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NASA Calls The SR-71 Blackbird To Active Duty

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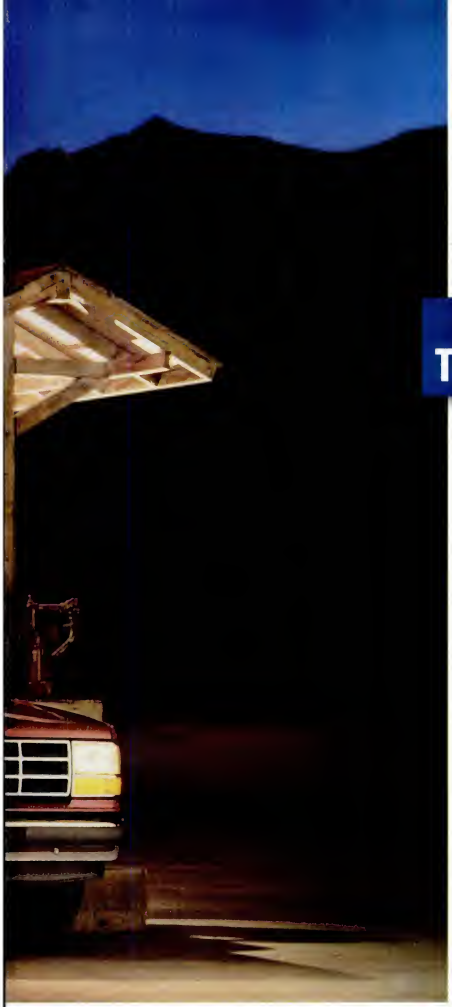

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EDITOR'S NOTES

● **Just when we thought** the SR-71 Blackbird was out to pasture, along comes NASA and calls three of them to active duty. The SR-71, for years America's premier intelligence-gathering aircraft, was "retired" by the Air Force last year after budget cuts and satellites grounded the Blackbird. As a last blast at its detractors, the bad Bird set a new transcontinental record on the way to the Air and Space Museum in Washington, D.C. (see Tech Update, page 18, June '90), once and for all firmly establishing the SR-71 as the fastest plane that ever flew.

Now, a scant year later, NASA has decided that the SR-71 would make a nifty research aircraft, giving engineers quick and easy access to both the fringes of space and the upper extremes of speed. This month's cover story was written by Maj. Terry Pappas, USAF. Pappas, an SR-71 aircraft commander for many years, is a command pilot with more than 5000 hours of flight time in SR-71s, B-52s and sundry other aircraft. He is currently an instructor pilot at Edwards Air Force Base, California. No one knows his way around a Blackbird like Pappas—unless it's his longtime RSO (reconnaissance systems officer), Maj. John Manzi. The full report begins on page 27. . . . **Remember when** you could just go into a store and buy a pair of sneakers? Today, there are more different kinds of sneakers than there are blondes in California. And the sneakers cost more than the blondes. So what's a guy to do? You can start by reading the first-ever in-use comparison test of big-buck sneakers that begins on page 35. We recruited five jocks on the POPULAR MECHANICS editorial staff and asked them to flog the shoes to death. The shoes, frankly, fared better than the staffers, most of whom were prone to flaccid feet after only hours of working out. . . . **Can American cars** be competitive qualitywise with the best from Japan? If you're talking about the Buick LeSabre, the answer is a rousing yes. Owners have raved about the quality of the car for two years running in J.D. Power surveys, and now our own Owners Report confirms that the Buick LeSabre is right up there in quality with legends like the Acura and Lexus. Check out the full results in this issue on page 39. . . . **What do you do** when a deck just isn't right for your house and a patio is too '50s? How about building a porch. They're back in style, and we tell you all in a complete guide to building (or repairing) a porch. It begins on page 62. . . . **Operation Desert Storm** turned out to be the proving grounds for many of our high-tech weapons systems that previously had been used only under simulated conditions. And what a result. One hundred days showed the world that high-technology can make up for lack of sheer numbers. "Lessons Of The Black Box War" on page 46 will influence war strategy for decades. Till next time.

PM PHOTO BY MIKE ALLEN

The PM test team: (clockwise, top left) Swan, Willson, Cannliff, Vizard and Skorupa.

Joe Oldham

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224 West 57 St.,
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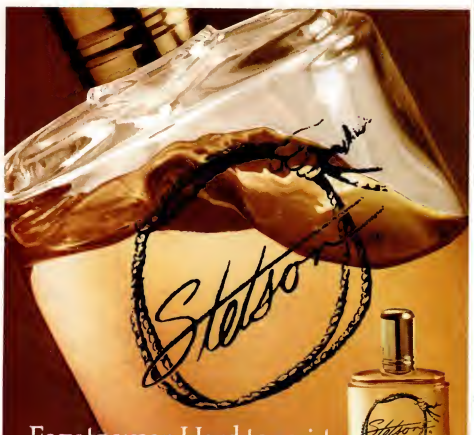

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ADVERTISING OFFICES

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224 West 57 St.,
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(212) 649-3164

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LETTERS

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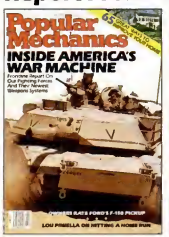
Report From Charlie Battery



Your article on Charlie Battery was fantastic. My soldiers and I truly thank you for your correct attention to detail and "soldier perspective." My females have been envious of all the male domination in other articles. This article definitely helped balance the scales. We especially liked the picture quality of all your photos. These soldiers were the unsung heroes of Desert Storm and it was great to give them the recognition they deserve. I was afraid that your article would focus on only a couple of technically oriented individuals from within my command. It was refreshing to see that I was incorrect in my assumption. You've definitely made a believer in me regarding the authenticity and honesty of your magazine. I will subscribe as soon as I return. Great stuff! Thanks again for a terrific representation of the Scudbusters.

CAPT. KEVIN P. GROOME
CMDR., CHARLIE BATTERY
OPERATION DESERT STORM

The information presented in America's Arsenal was informative, as far as it went. However, I am concerned about the absence of several very important weapons systems that played key roles in the Middle East battles.

How about some of these:

- The E-2C Hawkeye, a naval Airborne Early Warning aircraft, used by the U.S. Navy for long-range radar reporting of air and surface contacts, and for control of Navy fighters in a hostile environment.
- The Air Force's E-3 Airborne Warning and Control System (AWACS), flown during Operation Desert Shield and Desert Storm to gather information about Iraqi intentions and threats, and to defend Saudi Arabia from an Iraqi attack. The E-3 was one reason the early air campaign saw so few air losses.
- The AC-130 SPECTRE gunship with its complement of sensors and firepower.
- The C-130 AirBorne Command and Control Center, which made available information and intelligence to the ground commander.
- The Strategic Air Command (SAC), KC-135 and KC-10 tankers, used to refuel all those planes in the air. These flying gas stations made it possible for aircraft to take off with a lesser amount of fuel and more bombs. Once airborne, the fighter bombers would take on the gas needed to complete their missions.

The real thunder in any operation, however, is the young people who are willing to go all out for their beliefs and for their country, no matter which side.

TOM POMELOW, USAF, RET.
(Address not given)

I was extremely disappointed at your exclusion of the UH-1 Huey. The venerable Huey has been and still is an integral part of the Army. Its use as a general transport, gunship and, especially, medivac aircraft is unsurpassed. The UH-1 Huey is probably the one helicopter that is most likely to be seen because of its large numbers and widespread use.

MICHAEL DEY
KINGWOOD, TX

Radar Detecting

I am an old man whose days of fast cars and beautiful women are long gone. Yet, I own and use a radar detector. Why? Because many jurisdictions make money from careless and unknowing motorists by extending the city limits of the jurisdiction 1 or 2 miles out in the country where the speed limit (whether posted or not) is reduced automatically to city limits. When I traveled seven states in pursuit of my business, there were many times when I'd be at the 55-mph limit only to find myself suddenly in a 45-mph zone with police radar clocking my speed. Those of us with radar detectors know how often this can happen. My leadfoot days are past, my reflexes are slower and I drive a car with less power than I used to. It is unlikely that I will intentionally speed. But as long as some jurisdictions continue to fine motorists for being 5 miles per hour over the legal limit, I will continue to use a radar detector.

DALE CRANDALL
MARIETTA, GA

In a recent Letters column, a reader requested a navigation radar warning system. Has he ever tried an automobile radar speed detector? I have, and I receive definite blips from other ships at sea. If the blip is dead ahead or dead astern on either the direct port or starboard quarter, look out! The unit can be mounted on the end of a broom handle. I even mounted one in an upside down plastic dish pan for weather protection.

WILFRED S. TUCKER
PENSACOLA, FL

Winter Wonder

Thank you for your plans on building an oak sled for children. My wife is six months pregnant with our first child, and I figured it would be a great gift for our family, even though it's a bit premature. I built the sled secretly and surprised her. In the process, I made a few noteworthy changes. First, I made the slats wider and only used three. Instead of the round maple posts, I used rectangular oak posts. It was a little more work with my

(Please turn to page 10)

Child's oak sled built by reader Luis DeAndrade Jr.

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router to dado for the rectangular post, but I felt it would make for a more consistent look. The front crossmember is locked into the runners. I felt this would make it stronger since the sled would be pulled by this crossmember. I used brass screws because they blend into the wood color better than stainless. I screwed the runners onto the two main crossmembers for added strength and into the top of the rail at the back. Also, the handle has steel sides and an oak end to hold on to.

LUIS DeANDRADE JR.
BRIDGEWATER, MA

On The Right Road

Congratulations to POPULAR MECHANICS and Outdoors Editor Joe Skorupa for an outstanding special section on the Tread Lightly! program. Your magazine has been at the forefront of support for the effort, and I'm sure the interest generated by this section will help to ease the growing pains of Tread Lightly!, Inc., and its dedicated staff.

WILLIAM E. BAKER
VICE PRESIDENT, CORPORATE COMMUNICATIONS
RANGE ROVER OF NORTH AMERICA, INC.

I really appreciated the Tread Lightly section. You were right on track. After 24 years of the 2-wheeled experience, virtually all of it has been off-road with 40% trails and 60% closed-course practice and racing. The technique mentioned to avoid spooking a horse is just perfect and very important. Spark arresters do not come on motorcross motorcycles and only on one model of enduro-type bikes. They are, however, easy to install in about 5 minutes. They cost from $40 to $50 for ones that bolt on to existing mufflers, and around $90 for a 1-piece muffler/spark arrester. A screen inside or cones for particle deflection are the current designs. You can only ride closed-course, private race tracks without one. You also need your registration and off-road frame sticker with you unless you're on a private track.

GEORGE WALLACE
MOORPARK, CA

As a new subscriber to PM, I'd like to comment on your off-roading guide. Michigan has neither rocky out-crop nor desert for off-road vehicles. And Lake Michigan's dunes have too fragile an ecosystem for consideration. Thus, it is impossible for dirt bikes, ATVs or 4x4s to "Tread Lightly" and avoid environmental damage.

Snowmobiles might be okay when used on deep snow or frozen lakes, although their irritable whine still pollutes the beauty of Michigan's North. On thin snow, they wreak almost as much havoc as dirt bikes and ATVs.

The ugly scars left by dirt bikes, ATVs and 4x4s have ruined this beautiful state. Denuded, eroded, slashing wickedly and unnaturally across the landscape, those so-called trails are eyesores. Damning evidence of a hobby run amok. Off-roaders are just like motorcyclists. Bikers righteously insist that they are law-abiding motorists who deserve their place on the road. Yet, the minute traffic comes to a standstill, they cannot resist moving between the lanes or scooting along the shoulder. So, too, the off-road crowd, as disciplined as they set out to be, cannot resist gunning it on a slope or through a soft spot. The machines are irresistible.

To me, the only acceptable off-road vehicle might be a very low-powered machine—with even a governor or regulator attached to limit speed—ultra quiet, with oversize swamp tires sans sharp nubs or tread.

FRANK P. HOGAN
GROSSE POINT FARMS, MI

Your Tread Lightly section was excellent. I strongly agree with you about how snowmobiles wreck the ground, and I'm happy that you informed your readers about the problem.

I snowmobile and enjoy it. But if there isn't much snow on the trails, I stay off them. I also don't go fast on land. I save it for the lakes.

When visiting Michigan in the summer, I went for a walk and looked at the ground where I had gone snowmobiling during the winter. There was no vegetation, just dirt.

I think it's okay to snowmobile as long as you don't overdo it. It takes many years for nature to put things back the way they were.

JERRY HALL II
OAK LAWN, FL

Air Down Under

In your Boating '91 guide you referred to a product called Diveman which appears to be a bladder and air pump type of system allowing a swimmer to explore the depths of the ocean down to 20 ft. Unfortunately, your article could mislead the uninformed and uninstructed general public that this device can be safely utilized without prior training in the proper use of compressed air. I've been an active scuba diver for 27 years, a charter boat operator for 17 years and formerly a diving instructor for the Professional Association of Diving Instructors and the YMCA.

Improper use of this item could lead to pressure-related injuries such as air embolism, pneumothorax and other pressure-related problems that lead to brain damage, paralysis and even death.

CAPT. MICK TRZASKA
(Address not given)

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2. The sponsors are not responsible for incomplete, late, lost, postage due, misdirected mail or correspondence. Limit one design entry per person, group or organization.
3. Submitted entries will be evaluated by the editors of Popular Mechanics Magazine. Entries will be judged on the basis of: A) Originality 50%, B) Aesthetics 15%, C) Uniqueness 15%, D) Function 10%, E) Soundness of Design 10%. In the event of a tie, the winner will be judged on the accuracy and clarity of the submitted plans. By entering this contest, entrants accept and agree to these rules and to the decisions of the judges, which are final and binding.
4. The design must be original and must be owned by the entrant. The design must not have been previously built or have won any award. All entries become the property of the sponsors and will not be returned. The winning entrant will be required to execute all necessary documents to transfer any right, title or interest in the design they have created for their entry without additional compensation.
5. One Grand Prize: The Ultimate Liquor Cabinet built to the winner's design and material specifications. The prize includes the acquisition of all materials, labor and shipping and handling costs to the address specified by the winner (approximate value (not to exceed) $5,000.00). The actual prize value of the winners' Liquor Cabinet is determined by the winners' materials and specifications, therefore, the prizes' dollar value may be less than $5,000.00. In such a circumstance the cash difference will not be awarded.
6. The winner will be notified by registered mail on or about February 7, 1992 and will be required to sign an Affidavit of Eligibility and Release and consent to the commercial use of their name, likeness and winning design without additional compensation. The Affidavit of Eligibility and Release must be returned within 20 days of senders' postmark, or eligibility will be forfeited and an alternate winner will be selected.
7. This contest is open to residents of the U.S.A. who have attained twenty one years of age as of May 15, 1991, except employees and their immediate families of Hiram Walker & Sons, Inc. and Popular Mechanics Magazine, and the Hearst Corporation, their subsidiaries, affiliates, licensed distributors, retailers, advertising, and promotion agencies, including Marden-Kane, Inc. Void where prohibited or restricted by law. All federal, state and local laws, statutes or regulations apply.
8. The prize can not be substituted or transferred by the winner. Taxes are the sole responsibility of the winner.
9. For the name of the prize winner, send a stamped, self-addressed envelope to: "WINNERS LIST, THE ULTIMATE LIQUOR CABINET CONTEST," P.O. Box 705, Sayreville, NJ 08871. The winner's name will be available on or about March 20, 1992.
10. Popular Mechanics editors will not enter into any conversation or correspondence with any entrant regarding this contest or its rules.

THE ULTIMATE LIQUOR CABINET

SCALE 1" = 1'-0" DATE 2/18/91 DRAWN BY Art Chrysler

DETAIL B-B

THE ULTIMATE FINISHING TOUCH.

MIRROR SMOKE GLASS SPECIFICATION LIST

1/4" CHERRY VENEER GRAIN ORIENTATION AS SHOWN

SEE DETAIL A-A

15

16 3/4

3/4

22

24

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TIME MACHINE

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75 YEARS AGO: JUNE 1916

Airship Down

Blimps and zeppelins were the rage, but all it took was a storm to deflate the airship's image. For example, the U.S. Navy decided to go lighter than air with a frameless dirigible. But the Navy's first blimp, the DN-1, arrived in Pensacola, Florida, just in time for a gale. Ripped from its moorings, the airship drifted 75 miles before belly-flopping into a swamp. Meanwhile, German zeppelin Luftschiff-19 fell victim to a North Sea squall, earning a place on our cover.

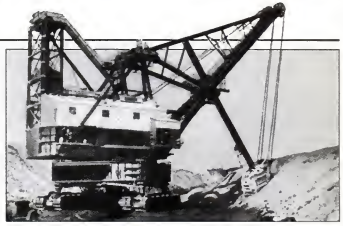
Fathoming The Depths

Before there was sonar, oceanographers had to dream up complex schemes to chart the ocean bottom. One idea was to link two wheeled submarines by cable and walk them across the sea floor, each sub leashed to a ship by an access tube. The subs would crawl side by side until an obstruction caught the cable. From the angles by which the cable deflected, the submariners could gauge the snag's position.

50 YEARS AGO: JUNE 1941

Diesel Dynamo

The railroads were undergoing a power switch: Steam was on the way out, diesel-electric was in, delivering high efficiency. The world's most powerful freight locomotives rolled off GE's Electromotive assembly lines. Typical was the power unit that pulled the Santa Fe No. 100, which drew 5400 hp from four Electromotive V-16s. These legendary F-series locomotives were cousins to the diesel streamliners that were muscling in on the passenger business.



Big Digger

Meanwhile, other mechanical titans stalked the American landscape. One such megamachine was the Bucyrus-Erie excavator. Balanced on four caterpillar traction feet, this oversized power shovel swung a dipper that was roomy enough to hold 52 men.

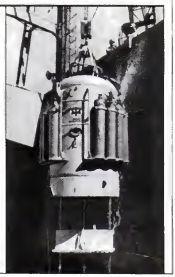
25 YEARS AGO: JUNE 1966

Lawn Ranger

A 3-wheel garden tractor that you built from a kit? What better project to whet both automotive and homeshop interests? And the machine itself had a lot going for it. It could turn on a dime, thanks to front-wheel drive and an arrowhead configuration. A single handlebar controlled throttle, braking and steering. The garden tractor weighed 300 pounds, half of which was dead weight to keep it stable, but its 3½-hp engine could haul a trailer loaded to 3500 pounds.

Briny Mining

During the 1960s, the ocean floor offered as many lures to engineers as the Moon. The big difference: the seabed's immediate payoffs in oil, ore, diamonds, even food. Remotely operated vehicles like Shell Oil's *Mobot* were already roaming the sea bottom, while divers tried out pressurized habitats like Westinghouse's *Cachelot* (right). Poised on the drawing board were deep-water dredging rigs for subsea strip mining and robots to tend submerged oilwells. **PM**



Paul Flinn, Construction Superintendent, Weatherford, Texas.
Over the past 40 years, he's never worked without his favorite hat. Or his Skilsaw.

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THE NEW BUICK EITHER THE COMPETITION OR WE'RE CHARG

*Based on EPA-estimated hwy. mpg
25 Roadmaster/23 Town Car, multiplied by the fuel tank capacity.
†Manufacturer's suggested retail price including dealer prep and destination charge. Tax, license and options additional. Levels of equipment vary.

GM · Let's get it together...buckle up.

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ROADMASTER. IS CHARGING TOO MUCH, ING TOO LITTLE.

	'92 Buick Roadmaster Sedan	'91 Lincoln Town Car Executive Series
Engine	5.7-litre V8	4.6-litre V8
Anti-lock braking system	Standard	Standard
Driver-side air bag	Standard	Standard
Drivetrain	Rear-wheel drive	Rear-wheel drive
EPA-est. hwy. range*	575 miles	460 miles
Seating capacity	6 passengers	6 passengers
M.S.R.P.†	**$21,445**	**$30,038**

The new Buick Roadmaster is everything you'd expect from a luxury car. Its standard features include full-size comfort and big V8 power. The security of anti-lock brakes and a driver-side air bag is standard, too. And of course, it's built to the exacting standards of Buick quality. So how come the new Roadmaster costs thousands less than the Lincoln Town Car? Simply because at Buick, we still make *value* a standard feature of every car we sell. For more on what is perhaps the best value in American luxury sedans today, call 1-800-238-2929.

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TECH UPDATE

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News Of Tomorrow's Technology Today

PM ILLUSTRATION BY EDVAN KUPKY

Army's Superdozer To Breach Future Minefields

FORT BELVOIR, VA—When the time came to penetrate the minefield laid by Iraqi forces along Kuwait's southern border last February, American and Pan-Arab forces had it easier than expected. Not only was Iraqi resistance weak, but U.S. combat engineers led the charge with technology developed for the Army's obstacle-breaching machine of the future.

The Combat Mobility Vehicle (CMV) is destined to replace the M728 Combat Engineer Vehicle and the M9 Armored Combat Earthmover. Along with its telescopic excavating arm, designed to level berms and fill tank ditches, the CMV will feature a new V-shaped mine-clearing rake.

Driven through sand or loose soil, the rake lifts mines and pushes them to either side of the vehicle, leaving a trail broad enough for armored vehicles to tread. Last December, the Army's Belvoir Research, Development and Engineering Center rushed the rake into emergency production. By mid-February M1A1 tanks and other vehicles were sporting the device, fitted with a protruding skid shoe to keep the rake at a constant plowing depth. The CMV itself will gauge and adjust the rake's depth automatically via a microwave-based sensor.

The Army aims to field the CMV before the year 2000.

Combat Mobility Vehicle uses rake to clear land mines. Excavator arm can lift 2 tons when fully extended to 26 ft.

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributors: Mike Fillon, Bob Scheier

Highlights This Month

■ **Green Power**—Plants convert sunlight into electricity.
■ **Demo On Demand**—Commandos have a new tool to knock out bridges.
■ **Fusion's Future**—New worldwide effort to tame thermonuclear energy.
■ **Mines With Minds**—They don't just sit there, they go after their targets.
■ **Blow Pipe**—The pneumatic tube mounts a surprising comeback.
■ **Guarding Our Freedoms**—Bill of Rights Tour features state-of-the-art security tech.

(More Tech Update on page 20)

SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.

Lights 100's, 12 mg. "tar", 0.9 mg. nicotine; Kings, 17 mg. "tar" 1.2 mg. nicotine av. per cigarette by FTC method.

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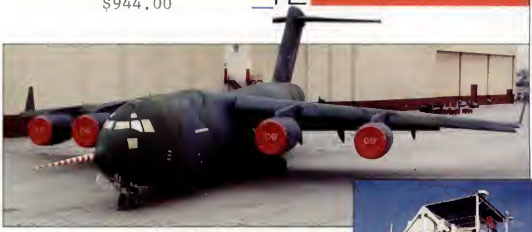
C-17 Set For First Flight

LONG BEACH, CA—This summer the Air Force will watch the future of its airlift capability take off for the first time. The C-17, built by Douglas Aircraft, is scheduled to begin flight tests next month.

Despite controversy surrounding cost overruns, the Air Force is standing by the C-17. The plane combines the short-landing ability of a C-130 with long-range carrying capacity closer to that of a C-5. It can tote 167,000 pounds 2400 nautical miles, yet touch down on a strip shorter than 3000 ft., thanks to engines that blow exhaust across wing flaps to enhance lift. Its comparatively stumpy 165-ft. wingspan allows better use of airfield space.

In addition, because the jets' thrust reversers divert air upward, pilots can keep their engines running during loading or unloading without kicking up dust. The reversers can also back a C-17 up a 2° ramp.

Military Airlift Command wants to buy 120 of the big jets, to replace C-130s and C-141s initially, and C-5s later.



MCDONNELL DOUGLAS PHOTOS

The C-17 (above) relies on winglets and blown-flap system (shown being tested, right) for lift on steep approaches to short runways.

Pond Scum Power

OAK RIDGE, TN—Although plants have thrived on sunlight for billions of years, only recently have humans tried harnessing plants' solar machinery for their own energy needs. At Oak Ridge National Laboratories, two such efforts are underway.

In the first study, researchers are using green algae to split water into hydrogen and oxygen. Both are byproducts of photosynthesis, the process by which plants convert sunlight, water and carbon dioxide into chemical energy. Pumped out of a bioreactor containing the algae, the gases could be run through a fuel cell to make electricity.

OAK RIDGE PHOTO

Green algae in a glass bioreactor photosynthesize under light and give off gases that power fuel cells.

The other project taps right into the flow of electrons touched off by photosynthesis. Chemists have extracted tiny chloroplasts, the "solar panels" of plant cells, and coated them with platinum. When exposed to light, the coated chloroplasts emit a current through the platinum. Small and responsive, the chloroplasts could fit into optoelectronic circuitry of future optical computers.

The Oak Ridge experiments dovetail with efforts elsewhere to replicate the chloroplasts directly.

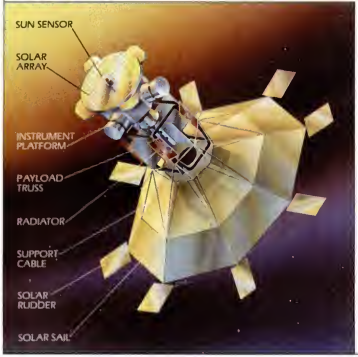
Solar-Sail Satellite

MOSCOW, U.S.S.R.—Now on Soviet drawing boards is a satellite that would maneuver in space using solar sails instead of attitude-control rockets.

Dubbed *Regatta*, the 1100-pound spacecraft could carry sensitive scientific instruments whose accuracy would be impaired by conventional thruster emissions. A 29-ft.-dia. solar sail and eight solar rudders would stabilize and control the satellite once in its designated orbit.

Astrophysicists at the Soviet Union's Academy of Sciences envision five *Regatta* missions, all tailored to collect data on plasma physics and the magnetosphere of the Earth. One would even swing around the dark side of the Moon.

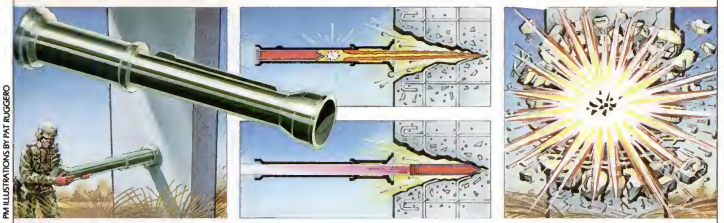
In addition, the Soviets have suggested using a *Regatta* as an early-warning satellite for solar storms. These flareups on the Sun's surface send waves of high-energy photons earthward and trigger damaging surges in electrical-utility equipment. The early-warning spacecraft would station itself at the libration point where the gravities of the Earth and the Sun balance out. Two U.S. satellite makers have also proposed early-warning spacecraft.



PM ILLUSTRATION BY DON MANKES

Regatta satellite would rely on solar sail and rudders to adjust attitude, avoiding adverse thruster effects.

(More Tech Update on page 21)



PM ILLUSTRATIONS BY PAT RUGGERO

Army Bridge Blaster

PICATINNY ARSENAL, NJ—The mission: Blow up a bridge behind enemy lines. To Army demolition specialists, that can mean lugging hundreds of pounds of plastic explosives and doing on-the-spot engineering under commando-raid pressure. But the Army intends to make the job easier with a single 30-pound tool that can knock out a 5 × 6-ft. reinforced-concrete bridge column.

Called a penetration-augmented munition (PAM), it is packaged as a portable tube. A magnetic sensor at the tube's mouth probes the column to find a space between steel re-bars. The tube then bolts itself to the concrete.

Triggering PAM sends a shaped-charge projectile tearing into the concrete, opening a channel for the main charge that follows. The detonation shatters the column from the inside out.

The Army is now testing PAM and aims for production in 1994.

PAM's initial shaped-charge blast carves hole in concrete. Then, main charge rockets into hole and detonates.

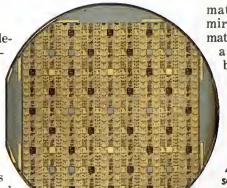
Microlasers En Masse

ZURICH, SWITZERLAND—Despite their kinship to microchip components, tiny semiconductor lasers (like those in CD players) aren't easy to fabricate in volume. But IBM engineers may have broken through the mass-production barrier with a technique borrowed from chipmaking.

Lasers of any size need mirrors, and making micromirrors has been the bottleneck in microlaser manufacturing. Conventionally, the mirrors are made after the laser is removed from the wafer—by cracking its semiconductor material to form a reflective surface.

The IBM method forms the mirrors while the lasers still reside by the thousand on a wafer of semiconductor material. Engineers etch mirrored trenches into the material, then fill them with a semireflective coating to boost the performance of the lasers.

Not only will the full-wafer technique speed mass-production, it will aid integration of optical and electronic circuits.



IBM PHOTO

A 2-in. wafer holds 5000 semiconductor lasers, whose mirrors are trenches one 5-thousandth of an inch deep.

Star Wars Bull's-Eye

KWAJALEIN ATOLL, MARSHALL ISLANDS—While Patriots held the missile-defense spotlight last winter, a far more advanced technology was rehearsing high over the Pacific Ocean.

The Army's Strategic Defense Command was trying out Lockheed's Exoatmospheric Reentry-Vehicle Interceptor Subsystem (ERIS), which would nail incoming ballistic missiles. The first test of the system was a bang-up success.

First, Vandenberg Air Force Base launched a Minuteman ICBM, targeting a remote Pacific Ocean locale. Satellites and ground radar handed trajectory data over to ERIS controllers. The 3-stage ERIS rocket blasted off and, en route to the missile, received several course-changing updates from ground control.

Meanwhile, the Minuteman released decoy balloons and a blank reentry warhead. Once the ERIS kill vehicle separated from its boosters, it used an infrared telescope and image-processing circuitry to distinguish decoys from its true target.

At the same time, a booster adapter section began a flight path parallel to the kill vehicle, training a battery of sensors to record the intercept. Just before impact, the kill vehicle unfurled a plastic umbrella to ensure collision with its target.

Two more demonstrations are planned for this year.

LOCKHEED PHOTOS

ERIS test vehicle [far left] stands in silo prior to launch. Kill vehicle [left] undergoes final assembly.

(More Tech Update on page 22)

$976.50

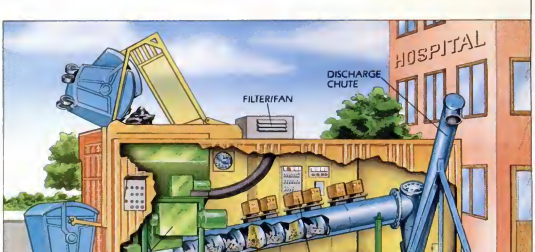
Microwave Waste Zapper

ROSELAND, NJ—The cost of controlling incinerator emissions has prompted a search for better ways to dispose of infectious medical waste. Now, an automated treatment system developed by ABB Sanitec uses microwaves to kill dangerous germs.

First, hydraulic lifters empty a dumpster into a feed hopper. There, two counter-rotating shafts shred the waste while steam percolates through to prevent germs from becoming airborne.

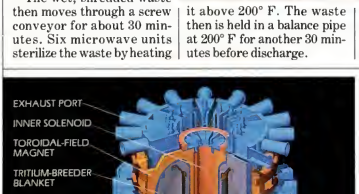
The wet, shredded waste then moves through a screw conveyor for about 30 minutes. Six microwave units sterilize the waste by heating it above 200° F. The waste then is held in a balance pipe at 200° F for another 30 minutes before discharge.

The system cuts the waste volume by 80%, and the residue can be treated like normal household waste.



On-site disinfection system zaps medical waste with 1200 watts of microwaves for a half hour, rendering it safe for removal.

PW ILLUSTRATION BY HANK IKEN



LLNL PHOTO

ITER tokamak, largest yet built, will use superconducting magnets to hold plasma. Breeder blanket will replace tritium lost in fusion.

The Future Of Fusion

LIVERMORE, CA—A fusion reactor that produces energy for more than a few seconds is the next step toward generating unlimited electricity from thermonuclear power. But such a machine—the prototype for a commercially viable fusion plant—could cost more than $6 billion to create.

With that in mind, the United States is collaborating with the Soviet Union, Japan and the European Community to design and build the International Thermonuclear Experimental Reactor (ITER).

The biggest superconducting magnets ever made will confine hydrogen plasma five times hotter than the Sun's interior. Meanwhile, a neutral-particle beam will pump energy into the plasma to trigger the fusion. The goal? Steady-state output of 1000 megawatts.

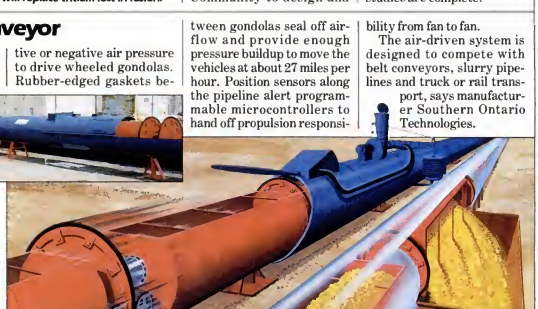
Construction wouldn't begin for at least six years, until studies are complete.

Air-Driven Conveyor

HAMILTON, ONTARIO—The pneumatic dispatch tube of the 19th-century department store is back in a big, rugged reincarnation, suited for moving gravel, ore and similar materials.

Along the pneumatic pipeline, fans create either positive or negative air pressure to drive wheeled gondolas. Rubber-edged gaskets between gondolas seal off airflow and provide enough pressure buildup to move the vehicles at about 27 miles per hour. Position sensors along the pipeline alert programmable microcontrollers to hand off propulsion responsibility from fan to fan.

The air-driven system is designed to compete with belt conveyors, slurry pipelines and truck or rail transport, says manufacturer Southern Ontario Technologies.



Cars emerge from lefthand pipeline (right), reenter and are unloaded dynamically. Photo shows first installation in Canada.

PW ILLUSTRATION BY DEAN ELLIS; SOUTHERN ONTARIO TECHNOLOGIES PHOTO

(More Tech Update on page 24)

THE POWER TO MOVE MOUNTAINS, 11,900 POUNDS AT A TIME.

THE DODGE CUMMINS TURBO DIESEL. THE HARDEST WORKING DIESEL PICKUP IN AMERICA.

The Dodge Cummins Turbo Diesel is one mountain of a truck. Its 5.9 liter Cummins turbo diesel engine cranks out 160 hp and a massive 400 lbs-ft of torque – the most torque of any diesel pickup.

Up to 11,900 pounds of pull, 4,846 pounds of payload.

With its 11,900 lb available towing capacity and up to 4,846 pounds of payload capacity, the Dodge Cummins Turbo Diesel is a true beast of burden.*

And with more available payload and towing capacity than any other full-size diesel pickup, it's easy to see why it's America's hardest working diesel pickup.

At an altitude of 10,000 feet, it's still going strong.

Being the only turbo diesel there is, the Dodge Cummins breathes thin mountain air with ease. Which means that at altitudes even as high as 10,000 ft, it doesn't lose any of its 160 horsepower. Ford and Chevy's naturally aspirated diesels, on the other hand, can lose up to 30% of their power at 10,000 ft.

Works through the worst of times.

For hot weather work, there's just no stopping the Dodge Cummins Turbo. The only full-size diesel pickup to offer a maximum engine cooling system along with an engine oil cooler as standard equipment. Order an automatic and the transmission cooler is standard too. There's also a new charge-air intercooler designed to deliver excellent fuel economy and a cleaner burn. While new engine improvements reduce oil consumption. And it's the only diesel pickup backed with unbeatable 7/100 engine and 7/70 drivetrain warranties.†

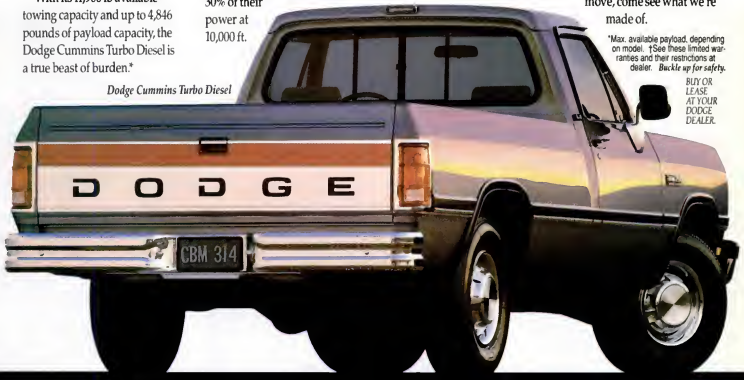
The Cummins Turbo Diesel intercooler delivers excellent fuel economy and a cleaner burn.

Welcome home to Dodge.

The Dodge Cummins Turbo Diesel, part of the Dodge full-size pickup line. And without question, the hardest working diesel pickup in America. No wonder people with big loads to haul are coming home to Dodge. So if you've got mountains to move, come see what we're made of.

*Max. available payload, depending on model. †See these limited warranties and their restrictions at dealer. *Buckle up for safety.*

Dodge Cummins Turbo Diesel



BUY OR LEASE AT YOUR DODGE DEALER.

Welcome Home, America.
Advantage: Dodge.

$1242.75

PM ILLUSTRATION BY ED VAJGURSKY

Land Mine Hunts Tanks

PICATINNY ARSENAL, NJ—Most anti-tank mines need to wait for enemy armor to roll over them. But the Army's new breed of mine will destroy vehicles as far as 300 ft. away from the mine.

The Wide-Area Mine (WAM) can be deployed by hand, rocketed into position or dispersed from the back of a truck. Once WAM is on the ground, eight legs spring out to pop the unit upright, and an acoustic sensor begins scanning the area.

WAM tracks any approaching vehicle and classifies it by engine noise and seismic rumble signature. If the vehicle is to be attacked, a small internal motor suddenly tilts the mine toward the target. WAM then launches a sublet over the vehicle. The sublet uses an infrared sensor to gauge its position, then fires a shaped-charge tantalum slug through target's top armor.

WAM listens for acoustic signature of enemy tank, then fires shaped-charge armor-piercing submunition unit.

Textron Defense Systems has an advanced development contract for WAM, which the Army hopes to begin fielding by 1994.

On The Road With The Bill Of Rights

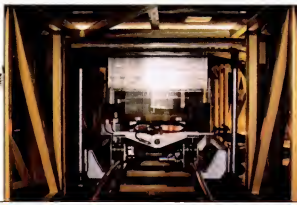
LOS ANGELES, CA—The piece of parchment that guarantees our basic freedoms is currently touring the nation, accompanied by a high-tech entourage of display and security equipment arranged by sponsor Philip Morris.

PHILIP MORRIS PHOTOS

Virginia's original copy of the Bill of Rights stays locked inside its capsule, which is filled with nitrogen to avert oxidation. The stainless-steel and acrylic container features the most rigorous environmental-control system ever designed for a document. Internal sensors constantly monitor temperature, humidity, pressure, shock and vibration. What's more, the document is never exposed to more than five foot-candles of light, to prevent photodegradation of the 200-year-old ink.

The capsule itself travels in a custom-built, blast-resistant armored car, which rolls out of a tractor-trailer upon reaching a show destination.

During a presentation, human hands never touch the capsule. Instead, the armored car docks with the viewing pavilion. Then a robotic motion-control system lowers the capsule onto a dolly, which conveys it along a rail system under the pavilion's raised floor. The capsule ascends via hydraulic scissor lift into the pavilion's viewing area during the presentation. It is then retracted and dollied over to a second viewing area. The 16-month tour is now working its way east, toward a final stop in Virginia in February of 1992.



Clockwise from top: Bill of Rights Tour exhibit pavilion, viewing area, dolly delivery of capsule via hydraulic lift, armored transport vehicle.

A FEW YEARS IN ONE OF THE WORLD'S LARGEST SCHOOLS CAN REALLY PAY OFF FOR A LIFETIME.

If you're like a lot of high school seniors, you may know what you want out of life, but maybe not how to get it. Well, if you're looking for high-tech skill training and a competitive edge, you'll find the direction you're looking for in the Army.

Qualify now for the Army's Delayed Entry Program, and training in any of over 250 fields will be waiting for you when you graduate—guaranteed in writing up to 12 months in advance.

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Popular Mechanics
JUNE 1991

NASA's Bob Meyer, Steve Ishmael, Marta Bohn-Meyer and Rogers Smith (left to right) will fly the Blackbird.

PM PHOTOS BY ERIC SCHULZINGER AND MICHAEL O'LEARY

THE BLACKBIRD IS BACK

Designed 30 years ago, and still the fastest plane ever built, the SR-71 Blackbird's retirement is about to end.

BY TERRY PAPPAS

● For three years I flew 70 tons of titanium-skinned fury known as the SR-71 Blackbird. Along with my reconnaissance systems officer, Maj. John Manzi, I ranged to the ends of the Earth at speeds and altitudes no other plane could touch, carrying out missions still veiled in secrecy. It was the greatest thrill of my career.

Late in 1989, Air Force funding for the Blackbird was canceled. According to the Pentagon, spy satellites could do the same job for less, and without risk to human life. America's irreplaceable fleet of 2000-plus-mph spyplanes was retired—some parceled out to museums, others left

to rot, and a few set aside should their country ever need them again.

Now, just over a year after flying into the history books, SR-71s are again being readied for flight. In keeping with the decline in East-West tensions, their new mission will be scientific, rather than strategic. This summer, as part of NASA's civilian fleet, three refurbished SR-71s will turn their unparalleled speed to testing exotic materials and designs for a new generation of even faster aircraft. The return of these fabled machines to flight prompts a look back at life with the Blackbird, and a look forward to accomplishments yet to come.

Skunk Works wonder

Kelly Johnson, father of the Blackbird and head of the legendary Lockheed Skunk Works, first proposed his high-mach theories to CIA leadership in 1958. His thinking rapidly gained acceptance after a volley of surface-to-air missiles brought U-2 pilot Francis Gary Powers down over the Soviet Union in 1960.

Thirty-one months of secretive work brought forth the A-12 (see "Saving The First Blackbird" on page 30), a single-pilot craft flown by the CIA. Setting the pattern for Blackbirds to come, it was a radical departure. With little more than slide rules to guide them, the Skunk Works team had selected a thin delta wing with moderate wing loading to allow flight at very high altitudes. A long, slender fuselage contained the landing gear, fuel and payload.

Sixty-thousand pounds of special high-flashpoint JP-7 fuel acted as a heat sink (later Blackbirds carried 80,000 pounds), keeping sensitive components cool at speed. Because atmospheric friction would raise surface temperatures to well above 500° F, the airframe's exterior had to be crafted entirely of titanium, a monstrously difficult metal to form. After landings, ground crews sometimes had to allow the aircraft to cool down for 30 minutes before they could touch it.

1960s vintage instruments in the formerly classified cockpit betray the Blackbird's age.

Further difficulties came from the fact that thermal expansion would alter the plane's dimensions by as much as 6 in. Wing surfaces were imprinted with corrugations that flattened out as they stretched, and the control system consisted of expandable cables, combined with a remarkable control assembly "mixer," a sort of mechanical computer that translates control inputs.

The Pratt and Whitney J-58 engines used a unique air-inlet system to produce unheard of amounts of thrust. The inlet spike at the front of each engine nacelle could be moved forward or back as much as 26 in. This allowed the shock wave to be positioned so that some of the entering Mach-3-plus air was decelerated for engine ingestion. The rest bypassed the engine and went directly to the afterburner section, producing a partial ramjet. At high speeds, this accounted for more than half of the Blackbird's total thrust.

The A-12 first flew on April 26,

The author is a former U.S. Air Force SR-71 aircraft commander, now assigned to the Air Force Flight Test Center as a T-38 instructor pilot.

PM PHOTO BY ERIC SCHULZINGER AND MICHAEL O'LEARY

GEORGE HALLCHECK SR PHOTO

1962. Soon after came the YF-12A. Crewed by a pilot and flight test engineer, these research birds flew under NASA for 10 years. On Dec. 28, 1962, Lockheed got the contract to build the first group of SR-71s, which were to become the largest and best known branch of the Blackbird family. Bob Gilliland made the first flight on Dec. 23, 1964.

One year later, the first SR-71 arrived at Beale Air Force Base, California, operational home of the Blackbird. Thus, in a remarkably short span of time, the Blackbird went from a radical concept to a working aircraft gathering vital intelligence for the United States.

Schooled for speed

My acquaintance with the Blackbird began with a selection and training process that has to rank among the most grueling in aviation. Roughly 4% of those who volunteered would be called out for a week-long interview. Half of those were selected for the program.

The interview began with a 2-day physical examination so exhaustive that it grounded a number of air crews—some of them permanently. The third day was spent in the SR-71 simulator. After a 30-minute scan of the cockpit and switches, we were basically thrown to the wolves, flying with multiple malfunctions heaped upon us for 8 hours. When it was over, we were tired, frustrated and had no idea whether we had done well or not.

The fourth day included two flights in a T-38 Talon supersonic trainer. One was flown with the squadron commander and the other with the chief SR-71 flight examiner, each evaluating our airmanship and flying skill. The last day was spent in one-on-one interviews with the wing commander and his entire senior staff, all of whom had to give us the thumbs up if we were to make the cut. Two months later, I learned that I had made it.

Maj. Manzi and I trained together, beginning with a 2-week T-38 checkout. Then came two months of SR-71 academics, followed by 10 months of the most demanding simulator training imaginable. Carried out by operational Blackbird crews, it reflected the fact that one day we'd be on our own, responsible for a mission of top national importance in an airplane considered to be an irreplaceable national asset. It was not fun. Some guys actually still hate their instructors. Then, six months and 200 simulator hours into training, we got to strap on a real Blackbird. Believe me, it was well worth the wait.

GEORGE HALLCHECK SR PHOTO

$1316.00 Double Spread

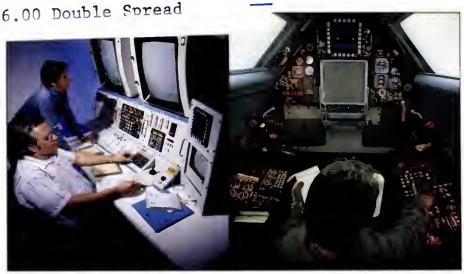
For the last six months we flew increasingly challe sion profiles, until finally the newest SR-71 crew, R-12 Pappas and Manzi, was certified Mission Ready and qualified for overseas deployment. It was November 1986. We were ready to take the Blackbird out by ourselves.

Flying the SR

There's nothing quite like releasing a Blackbird's brakes and slowly pushing both throttles to full military power, then into minimum afterburner. Things can become violent, as the two afterburners rarely ignite simultaneously, and the aircraft jerks hard to one side or the other. Once both burners are lit, it's time to push both throttles to full burner. The aircraft rumbles a little at first, resisting the tremendous forces, then it surrenders and it's one smooth ever-increasing rate of acceleration.

Things start happening very fast. Even a momentary lapse in concentration can cause everything to blur. Within seconds of brake release, you're at 180 knots indicated airspeed, and it's time to pull back on the stick. No sooner is the nose up than the aircraft's off the ground going 210 knots. The gear must be retracted immediately to avoid exceeding the gear-limit speed. Pulling the nose higher, we rapidly approach 400 knots.

Manzi and I exchange a few quick cockpit checks, and I settle in to just



PM PHOTO BY ERIC SCHULZINGER AND MICHAEL O'LEARY

Updated Singer-Link simulator is the centerpiece of NASA's air crew training program. Instructor's panel (left) governs all displays and controls in the simulated RSO station (right).

hanging on to this beautiful black animal. The vertical velocity indicator is pegged at maximum, and the altimeter is spinning like a top. I clear the flight path aggressively, glancing back inside the cockpit frequently to confirm that precise parameters are being met. With lateral pressure on the stick, I roll to intercept our outbound course, carefully checking bank angle, pitch attitude, indicated airspeed and angle of attack.

Two minutes after takeoff, John would hear me say "burners," alerting him to brace for the rough jolt that came when I throttled out of afterburner. Slowly pushing the stick forward to level off at 24,000 ft. and .9 Mach, we fly toward the air refueling track. Usually, we would take off with less than a full fuel load, giving us better performance and a wider safety margin.

During the climb, John stayed busy checking our reconnaissance and navigation equipment, and making sure we stayed on the "black line" that designated our planned route. Soon we approached our air refueling fix, where a couple of KC-135Q tankers were orbiting. Their crews were the best in the business, and they accomplished the demanding rendezvous time and time again, usually without speaking a word until we were hooked up and ready to take on fuel.

Saving The First Blackbird

● While a select few SR-71s are being restored for flight, most of the Blackbird brood faces a less happy fate, carted off for display at assorted museums and air bases around the country. What's sad about this is that it usually involves destroying them as flying machines. Vital wing spars are severed in order to make the planes narrow enough for transport.

One Blackbird spared this fate was that granted to the Intrepid Sea-Air-Space Museum. When museum director Zachary Fisher learned that he was to receive one of the 16 available aircraft, he was determined to preserve it intact.

His was no ordinary Blackbird. It was the first production A-12, and thus, the first non-prototype Blackbird off the Lockheed line. Although the SR-71 is better known, the A-12's single-pilot payload made it the fastest and highest flying of the breed. Its publicity-shy CIA operators never let it attempt any records, however.

Fisher dispatched deputy director Donald Francis and curator Scott Koen to retrieve the prize, which had been standing in the desert outside Lockheed's Palmdale facility for more than 20 years. Their mission was a daunting one. Although Blackbird wings were designed to fold at the nacelle for engine access, that still left the plane 39 ft. wide—too wide for California

Since nearly the entire body of the Blackbird was made up of fuel tanks, tanker boom operators often commented on its fluid appearance as it flexed in waves while I held tight formation behind them. It was one of the most taxing phases of the flight for me. And the cumulative effect of multiple refuelings and a long flight trapped in our space-suitlike flight gear was often exhausting.

Through the Mach

Fueled up, we began to gather speed. Surprisingly, breaking the sound barrier in modern aircraft is hardly noticeable, unless you're watching your instruments. Airspeed, altimeter and vertical velocity indicator all jump briefly due to pressure changes as the shock wave slides aft along the aircraft's surface. In the SR-71, the center of lift also shifts aft considerably, causing a heavy nose-down tendency. We frequently used a climb-and-descent maneuver called the dipsy to minimize the time and fuel required to make it "through the Mach."

The ensuing acceleration phase demanded my full concentration. To initiate the ramjet mode in the engines, it was necessary to move each inlet spike aft until the shock wave reached exactly the right location. The inlet was then started and running, supplying us with the power we needed to reach top speed.

The SR-71 was truly born to run. When we found ourselves at high

PM PHOTO BY ERIC SCHULZINGER AND MICHAEL O'LEARY

Complex SR-71 maintenance includes work on the mighty J-58s.

Mach in the Blackbird with less fuel than we needed, we pushed it up. That's right. We'd go even faster because the aircraft became more efficient. However, there were increased risks associated with the higher Mach.

Occasionally, we'd lose control of the shock wave entering one of the engines, causing a condition known as "unstart." The result is violent asymmetric thrust that can cause the cockpit canopy to slap you hard on the side of the head, while bringing on severe turbulence, erratic attitudes, and rapid altitude and airspeed changes. In other words, all hell breaks loose. Failure to recover the inlet could mean a long, bumpy ride down to safer altitudes and airspeeds.

Problems such as these have become far less frequent as the Blackbird's development has progressed. With the best maintenance in the world, this aircraft is incredibly reliable. It does, however, require a tremendous amount of logistical and maintenance expertise. Each flight was like a land speed record run. A lot of preparation goes into making an aircraft go the speed of a rifle bullet in the top 1% of the atmosphere.

But the view from 80,000 ft. made it all seem worthwhile. The cloudless sky is the deepest dark blue, almost black at times. Visibility stretches for hundreds of miles, and you can plainly see the curvature of the Earth below. On more than one mission, I've seen the Sun rise and set multiple times, as we outraced daylight across the planet's surface.

Upon completion of their first operational mission, members of each new air crew entered a select group. They each became a Habu, named for a cobra-like snake common on the island of Okinawa. When natives there first glimpsed this strange-looking black machine in the mid-'60s, they pointed and exclaimed, "Habu! Habu!" It was

(Please turn to page 104)

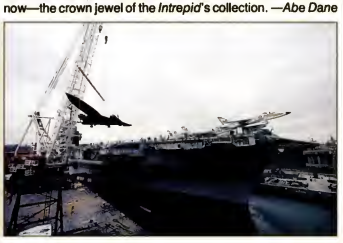
highways. They had to find a way to take apart the wing inboard of the hinge. No one, not even Lockheed, had done that before.

After deskinning the wings, Francis and Koen found what they needed: a splice joint that threaded between all the major wing frame members just inboard of each nacelle. With the help of some laid-off aerospace workers, they removed the bolts along the seam. The moment of truth came when a small hydraulic ram nudged the nacelle away, leaving it dangling from the end of a crane.

"As soon as we had both nacelles on the ground, it was a piece of cake," says Koen, half joking. All they had to do was get the 100-ft.-long fuselage and four other pieces, each of which constituted a wide load, across the country. They drove in convoy to Galveston, Texas, startling bystanders and stopping in to make a presentation at a high school along the way.

At Galveston, they loaded the bird on a barge, and pulled it around the Florida Keys to Jacksonville. After stopping to pick up a restored A-7E Corsair and an M-42 Duster mobile anti-aircraft gun, also destined for the museum, they headed on to New York.

The last step was to hoist the plane 60 ft. onto the deck of the retired aircraft carrier *Intrepid*, where the museum is housed. With the help of a 150-ton barge crane, the largest in the Northeast, it went off smoothly. For the first and only time in history, a Blackbird landed on the deck of a carrier. It rests there now—the crown jewel of the *Intrepid*'s collection. —*Abe Dane*



PM PHOTOS BY BRIAN WOLFF

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CHEVROLET BLAZER S-10

LONG-TERM TEST

Spring-cleaning at the PM garage—four veterans head for home.

● As spring heads toward summer, several members of our long-term fleet are headed back to their respective manufacturers. How well did they respond to the tortures of life in the Big Apple? Generally, very well indeed. But we have some footnotes.

Chevrolet Blazer S-10

Aside from trucks used by professional outback guides, we think few sport/utility vehicles see as much hard duty as our Blazer has over the past 10 months. And we also think few stand up to hard use any better.

In 10,449 miles, our Blazer has run on just about every surface imaginable, including lots of snow and slush during winter commuting. Its 4wd

TOYOTA PREVIA LE

PM PHOTOS BY ROY ATTAWAY

system has kept us going in conditions that defeat ordinary passenger cars, and we regard it as state of the art in terms of convenience.

We've also upgraded our opinion of the S-10 Blazer's towing capabilities. If the load has the aero properties of a barn—a horse trailer, for example—the Blazer labors. But when we hitched up a U-Haul car dolly to tow an Olds Calais, the Blazer did the job without even breathing hard.

Throughout our test, the Blazer averaged just over 22 mpg, and managed almost 25 in highway running. It doesn't use oil, and performance has improved with the miles.

As the Blazer heads back home to bowtieville, we have only two criticisms. First, we'd like to see Chevy reengineer the heating system with an eye to balancing air circulation between the front and rear of the vehicle. Second, we think there are too many squeaks and rattles, even allowing for hard use.

But on balance, we've been impressed with the S-10 Blazer's appetite for hard work and its all-around durability. —*Tony Swan*

Toyota Previa LE

Since its introduction almost two years ago, we've been itching to spend more time with the swoopy new Previa minivan. Accordingly, as our Pontiac Trans Sport evaluation neared its conclusion, we ordered a new Previa LE to replace it.

The Previa came with Toyota's All-Trac all-wheel-drive system, a 4-speed automatic transmission, a very nice AM/FM/cassette/CD sound system, air conditioning, antilock braking and 79 miles on the clock. The base price is $14,698, but our LE had a $26,237 window sticker.

We've put only 1078 miles behind us at this point, but we do have some initial impressions.

Tops under this heading is Previa's handling. This is the only midengined minivan—the 138-hp 2.4-liter dohc 16-valve 4-cylinder is under the front seats—and the weight distribution makes the Previa as balanced and precise as anything in its class.

The All-Trac system, which splits torque 50/50 front/rear (the basic Previa is rear drive), does a good job in slushy going, and the transmission makes the most of the power.

Regarding the latter, we expect to be more impressed once the Previa has acquired more mileage. New, it's a trifle sluggish off the line and a trifle noisy in hard acceleration.

We've also had problems with a sticky driver's-side power window, and we're surprised that Toyota neglected to build small-object storage—coins, for example—into the Previa's double-curved dashboard.

Fuel economy is okay so far at 21.2 mpg in all-around driving, and aside from the sticky window, we find the Previa's level of fit and finish up to Toyota's high standards. Ride quality ranks near the top of the minivan class, and we look forward to the miles that lie ahead. —*Tony Swan*

FORD ESCORT GT

PHOTO BY RON HUSKY

Ford Escort GT

With 6315 Southern California miles behind it, our Escort GT just keeps getting better. Our initial reservations about indifferent response from the Mazda-supplied 127-hp 1.8-liter dohc 16-valve 4-cylinder engine have long since evaporated. For pure go-power, the Escort GT ranks with the other subcompact hot rods.

The break-in process has also taken the notchiness out of the 5-speed gearbox, improving the feel and precision of the shifting.

As sporty subcompact handling goes, the Escort GT falls somewhere in the midpack. On canyon roads, we sometimes wish there was a little more roll stiffness and perhaps a little more in the way of contact patch than the 185/60R-15 tires afford.

On the other hand, ride quality is pleasant, and if the bucket seats lack lateral support for hard cornering, they're great for freeway cruising.

Although multivalve engines can be thirsty, the Escort GT continues to deliver excellent fuel economy. We've topped 35 mpg on the open road, and our lowest reading for a single tank, involving freeway rush-hour stop and go, came in at 26.7.

We've had no problems of any kind, indicating that this hybrid (Mazda platform, Mazda powertrain, Ford bodywork, Ford of Mexico assembly) is up to Ford quality standards. And

CARS

CHEVROLET CAPRICE CLASSIC

HONDA ACCORD EX

we continue to believe the Escort GT is a well-planned blend of performance, comfort and practicality.
—Rick Titus

Chevrolet Caprice Classic

One of the reasons that well over half of New York's taxis are Chevy Caprices is because they've proved they can take the pounding and abuse that goes with driving in Gotham.

Our experience with our 1990 Caprice Classic pretty much parallels that of the taxi drivers. With 12,743 miles on the odometer, most of them accumulated in and around New York City, our Caprice is as tight and rattlefree as the day we picked it up.

Generally speaking, we enjoy the Caprice's roominess and smooth ride on the open road. It also does a good job of ironing out New York's cratered thoroughfares.

Smooth also describes the Caprice's small-block V8, and if it's a trifle anemic when it comes to passing power, it compensates with decent big-car fuel economy: 16.8 mpg around town, 23.9 on the freeway. We should note, though, that in the last few days before our Caprice went home, we detected a moderate spark knock. A tank of 89-octane unleaded cured it, but through most of the test the Caprice ran well on anything.

We do find a couple other critical comments sprinkled through the logbook. The Caprice's handling, for example, leaves something to be desired in avoidance maneuvers—too much body roll, excessive understeer, sluggish transient response. We look forward to driving the Caprice LTZ, with a suspension setup designed to minimize these traits.

We also feel that Chevy should put larger mirrors in the outside housings. The glass is simply too small.

But in sum, we think Chevy has done a good job of updating the traditional American full-size car. We're particularly impressed with the Delco-Moraine antilock braking. GM's low-cost system brings ABS to the threshold of industry-wide affordability, which is, in our view, a far more important safety improvement than airbags. *—Tony Swan*

Honda Accord EX

With almost 15,000 largely carefree miles showing on its odo, our Accord is going home to Honda. Fuel economy remains unchanged at 24.2 mpg in urban commuting service and just over 29 on the cruise control. It uses virtually no oil between changes. It's been as reliable as a refrigerator.

Aside from the motorized seatbelt baulking from time to time and the irritating brake/shift lever interlock—engaging the Overdrive detent is a 2-step process from Neutral—we have no serious complaints.

On the whole, our Accord has been a solid performer throughout its term ...ice. It provides everything mainstream America wants in a small family sedan—comfort, roominess, good fuel economy and bulletproof reliability. And if our test staff finds it a trifle bland, we're nevertheless impressed with the subtle engineering that gives any driver an edge—outstanding sightlines in every direction and excellent control layout.

It's easy to see why this car is America's best seller. *—Mike Allen*

Pontiac Trans Sport SE

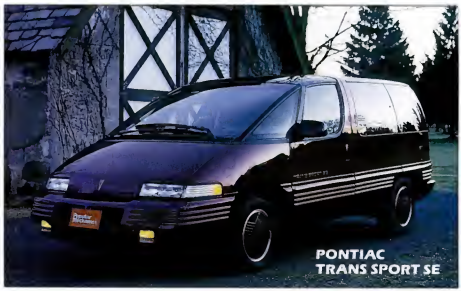
After nine months of serving as PM's errand runner, antique-show treasure hauler, furniture mover and all-around commuter, our Pontiac Trans Sport has gone home. We're sorry to see it go. Few minivans are as versatile and generally useful as this one.

This doesn't mean we don't see room for improvement. We regard the 120-hp 3.1-liter V6, though smooth, as no better than adequate, and we think a 4-speed automatic would do a better job than the 3-speed currently employed. (We understand from General Motors sources that both these criticisms will be addressed in '92 models.)

Over the course of 11,497 miles, the logbook shows several entries complaining about wind noise at freeway speeds. At suburban speeds, this noise is replaced by three or four persistent squeaks from the chassis.

All-around fuel economy over the course of the test rates as acceptable at 20.6 mpg, but only just.

On the other hand, the plastic bodywork has held its shape and finish exceptionally well, the head-turning styling promises to look new for years, and the easily removable seating is still best of breed. There are minivans with more grunt and better handling, but when it comes to adaptability, this one's tops. *—Tony Swan*



PONTIAC TRANS SPORT SE

HOT FEET

We go toe to toe in five superstar, cross-trainer sneakers to find out if they're high tech or hype.

BY JOE SKORUPA, Boating/Outdoors Editor
PM Photos by Brian Kosoff

● Nobody wears *sneakers* anymore. You wear Nikes or Reeboks or L.A. Gears. And, you don't run or jump or workout anymore, either. You pump up, get air or cross train. You do whatever one *bo*dacious athlete says because he seems to *know* everything about everything. Or you simply *do it*. Because *it* needs to be done.

Most of us are too smart to be fooled by superslick TV commercials, but it's hard to remain completely unimpressed, especially about athletic footwear. Let's face it, the simple sneakers of our youth have gone through some radical changes. Today, they come with cantilever soles, gel systems, air cushions, buckle straps and built-in pumps. Prices have changed, too. It costs about $100 to step out in shoes endorsed by megastars like Michael Jordan and Bo Jackson.

To make matters even more confusing, each athletic shoe has a sports-specific design. The 1991 Nike catalog, for example, is 164 pages long and features hundreds of highly specialized shoes. Do you really need a

$1616.00 DOUBLE SPREAD

closet full of $100-a-pair sneal you pursue more than one sport?

To find out, we went to the Midtown Manhattan branch of Herman's World of Sporting Goods and purchased 25 pairs of state-of-the-art sneakers . . . uh, sports shoes. We gave five pairs—midheight cross trainers from Asics, Avia, L.A. Gear, Nike and Reebok—to five PM editors. Then we tested them toe to toe for two months, analyzing their performance while running, working out with fitness machines, bicycling, playing basketball, racquetball, softball and just plain street walking.

Like other PM comparison tests, the ability to switch in midtest from shoe to shoe revealed striking differences in construction, design and performance. But unlike other PM tests, no hard data was produced. To pick the winner as objectively as possible, we established nine rankable categories and added up the results. We used a 1-to-5 ranking system, and the shoe with the lowest total won.

Reebok Pump SXT

Believe it or not sports fans, the Pump is for real. It may look gaudy and take some getting used to, but once it's dialed in, the Pump makes your feet feel like they're wearing custom-fit gloves.

The purpose of the Pump system in the SXT, which is unclear in advertising, is to provide a self-determining fit. Inflatable chambers are located in a wide tongue that surrounds the top and sides of the foot: Fill by squeezing an air-compressor bulb and deflate by pressing a release button. When properly inflated, the air chambers mold the shoe to your foot and provide tremendous lateral stability and ankle support.

Even without the Pump, the SXT

...K PUMP SYSTEM

TEST PARAMETERS

All shoes were purchased by PM from Herman's World of Sporting Goods in New York. Testing was conducted over a 2-month period. Five testers stressed the shoes in multiple fitness and sports activities. The winner was determined by adding up points scored in ranked categories. Bold numbers on each line in the chart indicate ranking.

MAKE/MODEL	1. REEBOK PUMP SXT	2. NIKE AIR TRAINER SC III
Overall Height/Heel Height/Weight	6.25 in./5.25 in./19.1 oz.	6.25 in./5 in./16.7 oz.
Support	1. **(tied)** Outstanding in heel and foot	1. **(tied)** Terrific, solid but flexible structure
Comfort	1. **(tied)** Excellent self-adjusting fit	2. Sensational, except for wide feet
Cushioning	1. **(tied)** Disperses shock of pounding	1. **(tied)** Air cushions do the job
Fit And Finish	2. **(tied)** Some glue showing, slight misalignments	2. **(tied)** One came with ragged inner lining
Style	2. **(tied)** Good, but for gaudy tongue, day-glo green	2. **(tied)** Great, except for busy strips and slashes
Durability	2. **(tied)** Superb, except one Pump had slow leak	3. **(tied)** One lace eyelet ripped out
Versatility	2. **(tied)** A bit heavy for running, otherwise great	1. A true multimission shoe
Special Features	The Pump inflatable chamber, midfoot stability bar	Air-cushioning system, Dynamic Fit inner sleeve
Price As Tested	$114	$109
Address	Reebok, 100 Technology Dr., Stoughton, MA 02072; (800) 843-4444	Nike, 1 Bowerman Dr., Beaverton, OR 97005; (800) 344-NIKE

Rubber Sole

Despite the differences in soles, the test team found no shoe provided better traction. Black soles, made with durable carbon, leave marks on indoor courts and aren't used on cross trainers.

(Strength Cross Training) is a well-made shoe. It received top marks for its lacing system, style, construction, cushioning and durability.

Despite its strong points, the Pump isn't for everyone. It's the heaviest shoe in the test and the most expensive ($114). Fit and finish was uneven: Glue showed in some seams, and the lateral-support bars were slightly misaligned. Breathability is minimal. And in one shoe, a slow air leak developed, prompting the tester to fill out a manufacturer warranty card in case it deteriorated further.

Also, the Pump SXT is only moderately versatile. It's best suited for workout routines and sports that involve only short bursts of speed. Basketball for more than an hour and jogging suffer because of the shoe's weight penalty.

Nevertheless, the Pump is a legitimate sports-tech breakthrough, and whatever the SXT does, it does extremely well.

Nike Air Trainer SC III

Like the Pump, the Nike Air Trainer bristles with trick features. Unlike the Pump, the Air Trainer's technology blends seamlessly into the structure of the shoe, like the clear window in the heel that offers a glimpse of the trademark air cushions. The sports-tech features and the shoe itself perform so well that you almost forget it's there. One tester likened the experience of wearing the Air Trainer to "the incredible lightness of being."

In addition to being lightweight, the Air Trainer scored high marks for its lacing system, style, cushioning, support and breathability. It was also the test's versatility champ—a shoe for all sports seasons.

So why did the Pump beat out the Air Trainer? The test team split on the effectiveness of the Dynamic Fit Sleeve, a system of elastic straps connected to the tongue that literally hug the foot like a glove. According to our testers, athletes with wide feet may not like this high-tech feature, while others may love it. Fit and finish was outstanding except for one shoe that had a ragged inner lining. In this same shoe, a plastic lace eyelet ripped out, which counted against it in durability. It was also our second most expensive shoe at $109.

Nike invented the cross-trainer concept and, with a few caveats, the Air Trainer is the closest thing to being a true multimission shoe.

Avia 1385

It's not surprising that the Avia cross trainer isn't as glitzy as the Reebok Pump. Avia is a division of Reebok, which apparently reserves top-of-the-line technology for itself. But this isn't necessarily a drawback. The Avia 1385 achieves modest success by focusing on fundamentals.

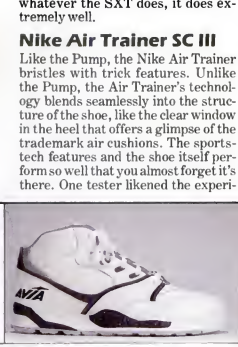
The two major features on the Avia 1385 are a cupped design at the heel, called a Cantilever sole, and something called ARC technology—a honeycomb of cushioning arcs in the forefoot made of flexible Hytrel. The effect of these highly marketed components is to provide a fair amount of cushioning that's good, but clearly a notch below the leaders.

The 1385 received high marks for its lacing system, fit and finish, breathability, durability and in the all-important versatility category. Also, lightness of weight and fairly good marks in comfort and support contributed to its do-it-all effectiveness. Eye appeal was above average, except for a speckle design that looks like a botched paint job.

Another modest plus for Avia is value. While the testers felt all the cross trainers were too expensive, the 1385 ($79) takes a less painful bite than Nikes or Reeboks. Overall, the nothing-fancy approach works well for Avia, but this may be about to change. A new top-of-the-line Avia cross trainer, the 1410, was introduced just as our testing came to an end. In addition to ARC technology and the Cantilever sole, the 1410 features something called a Compression Chamber in the heel and carries a high-tech price tag: $120.

L.A. Gear Muscle

Within the past couple of years, L.A. Gear high stepped its way into the



3. AVIA 1385
6 in./4.75 in./17.2 oz.
2. (tied) Fine in ankle, less in foot
3. Wide feet have trouble, others fine
2. Although low tech, one of the best
1. (tied) No glitches, well detailed
2. (tied) Nice clean look marred by white speckles
1. Takes a licking and keeps on kicking
2. (tied) Nothing fancy, but sound in the basics
Cantilever sole, cushioning arcs (ARC) in forefoot
$79
Avia, P.O. Box 23309, Portland, OR 97223; (800) 345-AVIA

4. L.A. GEAR MUSCLE
6.75 in./5.75 in./18.3 oz.
2. (tied) Fair in ankles, less in foot
1. (tied) Good overall, even for wide feet
3. (tied) Somewhat dead, but not bad
3. Some glue, stitching and lace system problems
1. Voted best dressed, good colors and design work
3. (tied) White polish scratches off, sole wears easily
3. (tied) A cross-trainer wannabe, best for walking
Self-adjusting arch, otherwise fairly simple
$69
L.A. Gear, 4221 Redwood Ave., Los Angeles, CA 90066; (800) 252-4327

5. ASICS GT LYTE
7.5 in./6.25 in./18.2 oz.
3. Ski-boot design is stiff, but loose
4. Awkward, bulky superstructure
3. (tied) Fair, one of its best sports-tech features
1. (tied) Great out of the box
3. Bulked up, garish buckle
2. (tied) No glitches except for quick wear on sole
3. (tied) Too heavy for running, indoor fitness best
Gel System, ankle collar with buckle strap
$100
Asics Tiger, 10540 Talbert Ave., Fountain Valley, CA 92708; (800) 766-ASIC

$1060.00

No. 3 slot in sports footw— Nike and Reebok. Mark had a lot to do with it and so did an emphasis on eye-pleasing design. But beyond these peripheral strengths, the test team didn't find much else to recommend in the Muscle.

The Muscle is indeed stylish. It is among the leaders in comfort, too. However, fit and finish was marred by glue showing in the seams and misaligned stitching. Durability became questionable when normal scuffing revealed that some forefoot leather was gray beneath a coat of white paint. Cushioning, support and breathability were judged fair.

In the category of lacing, the Muscle really shot itself in the foot. The shoes come out of the box double-laced —one white, one blue. To convert into a standard single-lace configuration, it took one tester more than half an hour. Tiny lace holes connect the soft inner lining to the outer leather. The connecting holes are sharply offset, either by design or by mistake, and a simple task turns into an unnecessarily difficult ordeal.

For street walking and fitness activities, where weight, ankle and cushioning protection are unimportant, the Muscle works fine. For true sports activities, the Muscle is strictly pecially occasional joggers and basketball players, this will not translate into genuine value.

L. A. Gear's next generation of sports technology, called the Catapult, was introduced recently in a basketball shoe. It consists of an air-filled rubber ball in the heel placed beneath a carbon-fiber strip, which flexes and springs back to its original shape. Perhaps the Catapult will eventually be installed in the Muscle and turn it into something more than a stylish street shoe.

Asics GT Lyte

Asics Tiger shoes made a big splash in the late 1980s with a new feature called the Gel System. It's a shock-dispersing component composed of a semifluid, silicone substance encapsulated in pads that are located in the heel and forefoot.

Hardly a ripple was made about another important feature—a thick ankle collar that requires a brightly colored strap and matching buckle to close. The effect of this gaudy, awkward element is to turn a light, flexible sports shoe into a stiff, heavy ski boot. Despite the shoe's height and stiffness, ankle support is minimal.

—le from potential marketing s, none of the testers could figure out the strap and collar's function.

On the plus side, the GT Lyte scored high marks in fit and finish, cushioning and breathability. But after a few uses, the GT Lyte's sole exhibited more wear than the other shoes. It is also limited in fulfilling its multimission capability. It's probably best recommended for indoor fitness activities that don't require much running.

Future Asics GT Lyte shoes are scheduled to feature a new technology called Exposed Gel, which may be little more than a clear window port in the soles. While the Asics' designers are at the drawing board, our testers would recommend that they turn their attention to items of genuine substance and consider dropping the ski-boot collar.

Perhaps no sports shoe can truly be all things to all people. But while specialization has its place, few would argue that buying a closet full of expensive footwear is the way to go. Cross trainers are currently the hottest sports shoe on the market, and they attempt to match the multimission effectiveness of old canvas-and-rubber sneakers. This is a welcome trend, but do they have to cost $100? PM

The Classic Sneaker: Seven Decades Of Cool

● To kids, sneakers are way cool. Not just high-tech, high-priced sports shoes, but genuine canvas-and-rubber sneakers. Kids at high schools, college campuses and rock concerts are just as likely to be wearing high-top, low-tech sneakers as Reeboks or Nikes. After all these years, sneakers are still at the top.

The Converse All Star, the quintessential canvas-and-rubber sneaker, was introduced in 1917. There've been modifications over the years, but the original design was so good, it appears to be timeless.

The All Star's role as a premier sports shoe, primarily for basketball, dates to 1921. This is the year an athlete named Charles "Chuck" H. Taylor joined the Converse sales force and traveled throughout the country spreading the sneaker gospel. Taylor was a star basketball player in the barnstorming pro leagues, which were popular 25 years before the formation of the NBA (National Basketball Association).

Through his own dedication, Taylor became much more than a traveling salesman. He hosted clinics and promoted basketball, which was invented by Dr. James Naismith in the late 1800s, in its fledgling years. Taylor's tireless efforts were rewarded with the nickname "Ambassador to Basketball." His input

at Converse also led to important changes in the original shoe, and, in 1923, his name was added to the ankle patch. Since that time, to aficionados, the most influential sports shoe of all time has become known as the Chuck Taylor All Star.

Taylor, who died in 1969, would be pleased to know that the sneaker that bears his name still sells at the rate of approximately 300,000 pairs a week. To date, Converse, based in North Reading, Massachusetts, has sold more than 500 million pairs overall.

A concession the All Star has made to modern times is a newfound emphasis on style and fashion. Today, since it is considered primarily a street shoe, the All Star comes in more than 50 colors, including traditional white and black, plus navy, red, denim, maroon, ice blue, purple, terracotta and something called raz.

A new generation of highly specialized leather footwear, starting in the late 1960s, finally surpassed the Chuck Taylor All Star as a performance sneaker. The torch has been passed to competition shoes with new designs and technologies.

Today, Converse Chuck Taylor All Stars are more likely to be seen on MTV than in the NBA, but the fact that they're still popular demonstrates the enduring appeal of the original, classic design. —*Joe Skorupa*

BUICK LESABRE

Buick cashes in on quality.

BY MICHAEL LAMM, Contributing Editor; PM Photos by Ron Hussey

● There's a new quality car on the block, and it's not Japanese. Nor is it German. It's made right here in the good old U.S. of A., and it's a Buick.

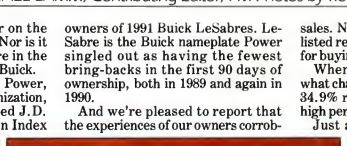
Who says so? For one, J.D. Power, the California research organization, says so. The much-publicized J.D. Power Customer Satisfaction Index tells us that Buick ranks right up there with the heaviest of heavy hitters—Mercedes, Lexus and Acura.

Power ranked Buicks—*all* Buicks—among the world's top 10 in terms of overall customer satisfaction. The Power group also tracked 1985 Buicks for five years, along with other makes, and ranked Buick among the top 10 for 5-year dependability.

While we respect the work of the J.D. Power organization, we've been in the customer satisfaction survey business ourselves for more than 40 years. Clearly, it was time for a PM Owners Report on Buick.

We sent questionnaires to 1000 owners of 1991 Buick LeSabres. LeSabre is the Buick nameplate Power singled out as having the fewest bring-backs in the first 90 days of ownership, both in 1989 and again in 1990.

And we're pleased to report that the experiences of our owners corroborate the J.D. Power index. According to our survey, 80.1% of our LeSabre owners had experienced no problems whatsoever. Our all-time top scorer in this category was the Lexus LS 400, with a troublefree rating of 89.6%, and the most recent Acura Legend we surveyed came in at 82.4%.



As you'd expect, Buick's quality story has had a positive effect on sales. Nearly 20% of our respondents listed reputation as their main reason for buying.

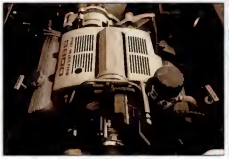
When we asked LeSabre owners what changes they'd like in their cars, 34.9% replied none—an extremely high percentage.

Just as impressive was the car's workmanship rating—98% of our respondents scored the LeSabre either good or excellent in this category. Our owners were plainly pleased the domestic make comes up to such high standards, and many told us they were glad to be able to buy American.

The current LeSabre arrived on the scene in 1986 as a member of GM's then-new H-body family, a group that also includes the Olds 88 and Pontiac Bonneville. The '91 LeSabre has undergone little exterior change since 1986, and Buick has obviously devoted engineering and manufacturing resources to making the car as good as possible.

BUICK LESABRE

Interior got high marks from owners for its roominess and comfortable seating.



Though smooth and quiet, 3.8-liter V6 lacks punch of GM's more sophisticated 3800 V6.

LeSabre's gauge cluster would benefit by addition of bigger tach and speedometer.

The LeSabre also shares its 110.8-in. wheelbase and front-wheel-drive platform with the new Buick Park Avenue series. However, unlike the Park Avenue, the LeSabre is the last Buick to use the LN3 165-hp version of GM's 3.8-liter V6 engine. The rest of Buick's bigger cars use the marginally more potent L27 3800 version of

SUMMARY OF 1991 BUICK LESABRE OWNERS REPORTS*

Total miles driven	**1,938,076**	Comfort/roominess	38.5	Average	2.3	Good	45.9
Purchase price:		Handling	33.3	Poor	1.3	Average	8.2
Average	$18,069	Fuel economy	23.8	**Rear-seat comfort:**		Poor	3.1
Range	$14,343-$22,261	Power/performance	17.2	Excellent	50.8%	**Number of vehicles owned:**	
Average miles per gallon:		**Specific dislikes:**		Good	44.8	This vehicle only	40.6%
In town	20.5	No complaints	20.0%	Average	3.7	Two vehicles	34.5
On the highway	27.2	Shoulder harnesses chafe	19.3	Poor	0.7	Three vehicles	16.5
Major options:		Fuel economy	5.2	**Any mechanical problems?**		Four or more	8.4
Power windows/locks	97.1%	Squeaks/rattles	4.3	No	80.1%	**Principal driver:**	
Premium sound system	80.6	Power door locks	3.8	Yes	19.9	Female	37.0%
Alloy wheels	36.5	Paint chips too easily	3.8	**Types of problems:**		Male	34.1
Tachometer/gauge cluster	29.3	Price	3.3	Air conditioning	13.1%	Equal	28.9
Antilock brakes	26.7	**Suggested changes:**		Electrical system	13.1	**Owners' age distribution:**	
Automatic load leveling	22.0	No changes	34.9%	Power locks	8.2	Under 29	1.0%
Leather upholstery	15.0	Improved shoulder belts	9.6	Power windows	8.2	30-49	15.8
Why did you choose the LeSabre?		Airbags added	6.4	Transmission	8.2	50-plus	83.2
Owned Buicks before	43.7%	Improved fuel economy	6.4	Oil leaks	6.6	**Would you buy another Buick again next time?**	
Styling	27.2	Standard antilock brakes	4.0	Noisy brakes	6.6	Maybe	65.2%
Reliability reputation	19.7	**Workmanship rating:**		**Did you handle repairs?**		No	24.0
Price	11.5	Excellent	55.6%	No	98.4%	Yes	10.8
Size	9.0	Good	42.4	Yes	1.6	**Based on experience, would LeSabre be your choice again?**	
Performance	8.6	Average	1.6	**Dealer repairs satisfactory?**		Yes	73.6%
Specific likes:		Poor	0.3	Yes	82.7%	Maybe	21.5
Styling	41.4%	**Front-seat comfort:**		No	17.3	No	4.9
Ride	39.2	Excellent	60.3%	**Dealer service opinion:**			
		Good	36.1	Excellent	42.9%		

* Percentages might not equal 100% due to rounding up or insufficient data.

the same powerplant.

LeSabre comes in 2-door and 4-door body styles, and it's interesting to note that the sedan has the edge in trunk space—16.4 cu. ft. versus 15.7. Standard equipment includes air, automatic transmission, power steering, AM/FM/cassette stereo, tilt-wheel steering and automatic front shoulder belts.

The LeSabre's automatic front seatbelts produced the only major gripe about the car. Nearly 10% of our respondents complained that the belts rubbed their necks. Another 6.4% thought their cars should have been equipped with airbags, and 4.0% felt that antilock brakes should be standard equipment.

GM says both these safety features will find their way onto the standard equipment list soon, which should enhance the next-generation LeSabre's appeal even more, since 26.7% of our respondents paid $925 extra for the ABS option.

Comfort quotient

The vast majority of our owners found their LeSabres comfortable, quiet and responsive. Those who'd owned Buicks before—43.7%—appreciated the 6-passenger spaciousness.

Buick's DynaRide independent suspension also got good marks, with 39.3% rating LeSabre's ride quality good and 54.9% rating it excellent. Ride quality, in fact, was second only to styling among the car's best-liked traits.

The combination of good acceleration and respectable fuel economy also pleased owners. A few told us the tank, rated at 18-gallon capacity, will take as much as 21.5 gallons, with careful topping off. Combined with an owner average mpg of 27.2, this yields a range between refills of well over 500 miles.

Among the few problems cited by LeSabre owners, the most common were electrical—sensors, lights, engine computer, door locks and power windows. A handful also mentioned cold-start stalling and balky warm-ups. But all these complaints were relatively scattered.

The bottom line

The acid test in all PM Owners Reports is whether the respondent would buy the same car if he or she had it to do all over again. A solid 73.6% of our LeSabre owners said yes, while another 21.5%, waiting to get a look at the next-generation LeSabre (due this fall), said maybe. Only 5% gave us a flat no.

What this tells us is that Buick's quality program is solidly on track and paying dividends. **PM**

Due for a styling change next year, the Buick LeSabre's looks nevertheless ranked as the No. 1 reason for buying with owners in the survey group. Ride quality, roomy interior and all-around comfort also got high marks. Over 80% of owners reported no problems.

EDITORS REPORT

LeSabre Glitch Patrol

● Like most owners of late-model Buicks, we've been impressed with the solidity of the cars coming out of Flint the past few years. And we welcomed the chance to spend a week with a '91 LeSabre in Detroit.

Naturally, we devoted a fair percentage of this time looking for glitches—things that were obviously wrong, as well as subtle changes that would make this car even better.

We're happy to report that our LeSabre glitch patrol yielded a very short list of negative comments. The 3.8-liter V6 is generally quiet and smooth. Controls are within easy reach, and large knobs make adjustments simple. Passenger space inside is about as roomy as you'll find in a passenger sedan this size. And the ride is excellent.

When we returned the car, we felt that Buick's quality claims for the LeSabre—tops in the U.S.—are easy to believe. And overall, we agree with the owners' responses. This car strikes a very good balance between economy, acceptable performance, comfort and good handling.

We also agree with some of the owners' specific criticisms, particularly the irritation of the front seatbelt. Also, though generally acceptable, the V6 is a trifle anemic when you need power at low speeds, which leads to excessive noise as the transmission steps down. The full-dial instrument panel needs separation of size and distance between gauges. We like the white-on-black color scheme, but the speedometer and tach should be larger to set them apart from the other gauges.

Our list of things to like, however, offsets these relatively minor nit-picks.

Tops on this list is how quiet the LeSabre's interior is, particularly at highway speeds. This is due in part to the low engine speed—1600 rpm at 65 mph. Low rpm also equals good fuel economy.

Interior space is ideal. You may never carry six adults at one time, but the LeSabre's roominess also makes loading groceries or stashing a child's seat a low-hassle project.

We found fuel economy to fall into the acceptable range—over 21 mpg in the greater Detroit area, up to 29 mpg at steady highway speeds. The LeSabre ranks near the head of the fuel-economy class for cars this size.

We also liked the solid feel of the chassis. That spells quality, and holds the promise of long, troublefree service. Buick built in some extra support for the body—concentrating particularly on the area of the cowl—and the improvement is noticeable, especially on rough roads.

All things considered, we think the '91 LeSabre measures up as solid goods. And with Buick preparing a new style for '92, the end-of-model-run '91s could be one of this season's best buys. —*Jim Dunne*

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BEST OF SHOW

Here are our picks from the Consumer Electronics Show.

BY FRANK VIZARD, Electronics Editor

● New developments in consumer electronics first appear at the industry's Consumer Electronics Show each January and June. Here are some of the more interesting items now in stores.

CD Docking Station

JVC's new personal CD players include a docking station that is wired directly into a home stereo system. The personal CD player can now function as a home player. It gets recharged as well. The XLP50J lists for $250, while the XLP70J lists for $350.

PM PHOTO BY TREMONT ARCHER

Baby Maker And Lifesaver

Plan a child with the Swiss Lady watch (far left) from Fidelity Electronics of Miami, Florida. A product of German research, this timepiece indicates the most fertile days in a woman's menstrual cycle and the days most likely to yield a boy or girl. List price is $59. The Casio watch (left) measures the wearer's pulse rate for blood-pressure problems. The BP-100 lists for $150 and is available in August.

VCR And Editor

The Panasonic Super VHS PV-S4167 videocassette recorder also works as a video editor. A shuttle control lets you search through a videotape at 13 different speeds so sequences are easy to find. In addition, there's a Digital Auto Picture feature that boosts the video signal during playback. This feature can enhance dubs or improve the picture quality of heavily used rental tapes. List price of this recorder is $749.

Voice Translator

Want to converse in five languages? Buy—don't hire—an interpreter for about $250. Sold in the United States by British Boston Marketing of Totowa, New Jersey, the interpreter speaks English, Spanish, Italian, French and German. The pocket-size device has a 10,000-word, 65,000-phrase database, and the voice is very understandable. It also comes with headphones.

Handheld Video Editor

Slightly larger than a remote control, the Canon VE-100 video editor can memorize the cut-in and cut-out points for up to four separate scenes. Once the edit points are entered, the scenes are automatically assembled from the playback VCR to the recording VCR in the desired sequence. When not in use as an editor, the VE-100 doubles as a 7-function remote control. List price is $270.

Cordless Answerer

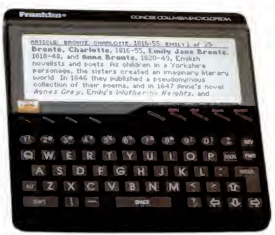
AT&T combines a cordless phone with an answering machine to make retrieving messages a snap. Messages can be heard three ways: through the cordless handset, from the base unit or by calling from another phone. An audible beep from the handset indicates an incoming message, so the base station can be placed out of sight. The handset needs recharging after seven days. List price is $300.

Cellular Phone, Pager Combined

The PagerPhone combines the convenience of a cellular phone with the utility of a pager. Made by Universal Cellular, Inc., of Anaheim, California, the PagerPhone is designed to reduce operating expenses for the mobile executive. The pager allows you to receive a message without getting charged cellular rates. List price is $1895.

Longer Videotape

If you like taping epics, never-ending soap operas or a night of basketball on ESPN, the 180-minute videotape from BASF is for you. The tape will preserve 3 hours of programming in the Standard Play mode, 6 hours in the Long Play mode and 9 hours in the Extended Play mode. List price for this blank tape is $11.



Palm-Size Encyclopedia

Put volumes of information in the palm of your hand, thanks to text compression technology. The Franklin version (above) is based on the Concise Columbia Encyclopedia and lists for $400. A Selectronics version uses the Random House Encyclopedia and lists for $350. Both models include a handy cross-referencing feature that makes gathering information easy. The Selectronics model, which opens and closes like a book, is the more portable of the two. Both weigh 12 ounces.

Race Like A Pro

You've always wanted to be a stock car racer, but you've never had the bankroll. Now, for a mere $54, you can try Bill Elliott's NASCAR Challenge videogame from Konami. The game puts you behind the wheel at Daytona, Watkins Glen and numerous other courses. Our Assistant Automotive Editor Mike Allen—a race car driver himself—found the game pretty realistic, although he notes it's difficult to drive smooth and fast. Gentlemen, start your engines!

Who's Calling?

This telephone accessory from Universal Electronic Technology Corp., in New York City, consults a 100-unit internal memory with each call. If the incoming caller is on the list, the person's name and telephone number is displayed. Otherwise, just the number appears. Who's Calling? also records up to 50 incoming numbers. There's also speed-dialing and rapid-search features, as well. This machine retails in stores for about $70.

Long-Range Cordless Phone

The Code-A-Phone Epic 9000 gives new meaning to the notion of long-distance telephone calling. While it looks like a typical cordless phone, the signal is actually transmitted from the handset to the base station on the 900 megahertz radio frequency. The base station then converts the signal for transmission on regular phone lines. The Epic 9000 claims a range of up to a half mile. That's long distance! List price is $250. PM

$1527.00 Double Spread

LESSONS OF THE

Forty-two furious days of Desert Storm have brought electronic weaponry from theory to battle-proven practice.

BY ABE DANE,
Science/Technology Editor
PM Illustration by Paul Dimare

● The bare arithmetic defies all conventional military logic. Outnumbered 2 to 1 by a battle-hardened, deeply entrenched army ranked among the toughest in the world, an international coalition goes on the offensive and retakes an entire country, losing less than 200 men. Better weapons, better soldiers, better morale and better leadership all play a part in the victory, but they fall short of a full explanation. It is a war won almost as if by magic.

There are indeed forces at work here that have little to do with war as we know it. One decisive fact stands out about Operation Desert Storm: Iraq was blind and we could see. Radar and electro-optic sensors borne by aircraft and satellites blanketed the battlefield, tipping us off to every movement of men or materiel. An elaborate structure of satellite and direct communications links relayed the

BLACK BOX WAR

data back behind the lines, where computerized command and control equipment made sense of it. Then, within minutes, or even seconds, orders and information were shot to the front, bringing almost immediate action. Meanwhile, an array of electronic warfare equipment put out an electronic haze that essentially gagged and blindfolded Iraq's military.

This dominating full-court press of the airwaves gave our commanders freedom to control the course of the war. They could engage the enemy when the odds were with us and avoid him when we were outgunned, maneuver with adroit precision and strike with devastating concentrations of force.

Invisible warriors

These capabilities followed from an unseen victory on a brand-new battlefield—a battlefield where the stakes were dominance of the invisible reaches of the electromagnetic spectrum. The warriors were less likely to be crews of fast jets than men sitting hour upon hour at computer consoles aboard lumbering converted airliners and transport planes. Their weapons were an untried generation of electronic equipment developed since the Vietnam War. Some had seen action in shadowy games of cat and mouse played along the borders of the Soviet Union during the Cold War. But no

one really kn___ $2210.00 Double Spread

Thus, just ... control ... vitally important to success in any other, Desert Storm proved that the same is now true for the airwaves. With the concept established, strategists around the world will spend the coming years dissecting the details of this first truly electronic war, seeking ways the new art may be perfected.

Out go the lights

For Iraqi radar operators, it usually began with a scope blanked out by static. Around the same time, communications with air crews and ground forces would start to go haywire. While it might have seemed that an electronic plague had suddenly invaded their equipment, the cause of the trouble was more likely many miles away. And the confusion was prelude to a brutal surprise.

In a typical scenario, EC-130H Compass Call aircraft would approach under the protection of F-15 fighters flying combat air patrol (CAP) high above. Trailing weblike antenna arrays between their tail fins, these converted versions of the trusty C-130 Hercules transport carry electronics gear designed to disrupt enemy communications.

"You're trying to buy time," says Maj. Lamont Noble, chief of the Compass Call Management Division of the Air Force Tactical Air Command. Leading up to a raid, the aircraft works in a passive mode, monitoring enemy transmissions. Seven operators working at computer consoles divide the radio spectrum among themselves and, under the direction of an electronic warfare officer, determine the signals to be jammed. Moments before the attack begins, their transmitters spring to life, blanketing the selected wave bands with electronic noise. "It takes awhile between when a guy hears that he's being jammed and when he switches frequencies and gets his communications net reconstituted," says Noble. "A delay of 2 minutes in getting a significant message through to a lower echelon can be critical, because the aircraft are traveling 8 to 9 miles a minute."

AVIATION WEEK PHOTO

Latest of the DSP missile-warning satellites awaits launch at the manufacturer.

Ravens and Prowlers

While Compass Call took out the enemy's ability to talk, radar-jamming aircraft such as the EF-111A Raven did the same to his ability to see. Adapted from the General Dynamics F-111A bomber, the swing-wing aircraft retains Mach 2.2 performance and 2000-mile range, but replaces the explosive payload with 7000 pounds of electronics. The plane's primary "weapon," the AN/ALQ-99E jamming subsystem, is an enhancement of the jammer aboard Navy EA-6B Prowlers, which also saw extensive action in the war.

A 16-ft., canoe-shaped radome slung along the underside of the fuselage houses the jammer's high-powered transmitters. Receiving antennas occupy a pod atop the reinforced vertical tail. In the cockpit to the right of the pilot sits the electronic warfare officer, operating computerized jamming controls that replace the navigation equipment and extra set of flight controls aboard a normal F-111. Under his direction, the jammer's processors scan for signals that match known radar types stored in computer memory. Countermeasures can then be activated, either automatically or manually, to match mission objectives.

The Raven, like its maritime cousin the Prowler, can use its radar-blinding abilities in a variety of ways. As a standoff jammer, it may hang back, staying out of harm's way while using the long reach of its transmitters to protect attack routes. On deep penetration missions, the EF-111A's fighterlike speed lets it hustle along with almost any attack formation, cocooning it in confounding signals. Other missions include masking an attack group as it forms up over friendly territory, and blocking battlefield acquisition radars in attacks on armor. Despite efforts to knock out Iraqi radars early in the war, jamming aircraft stayed busy for the duration, with missions frequently outnumbering aircraft available to fly them.

The Weasel's wallop

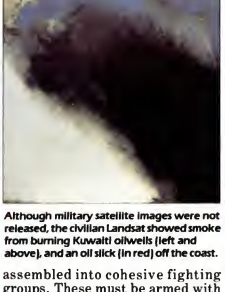
The knockout punch that often followed jamming of air-defense radars was delivered by the F-4G Phantom II Wild Weasel air-defense suppression fighter. Like so many weapons of the electronic battlefield, the F-4G is an unlikely marriage of new electronics and elderly mechanicals. Although the airframe, avionics and many other systems are shared with the venerable F-4E Phantom, the Wild Weasel is nonetheless state of the art. "The significant difference is that we have added the APR-47—a radar homing and warning receiver," says Randy Brown, F-4G program manager at the Aeronautical Systems Division of the Air Force Systems Command.

Going beyond the radar warning receivers carried aboard most fighter and attack aircraft, the APR-47 not only lets the air crew know their plane is being tracked by hostile radar, it also tells them exactly where that radar is located. The back seater's 7-in.-diagonal monochrome screen gives him a God's-eye view of the electronic

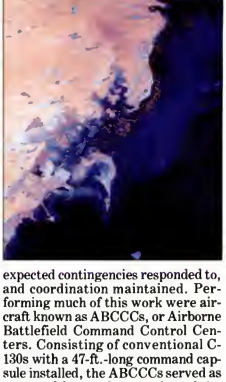
LINDSYS PHOTO

ABCCC III consoles coordinated air and ground phases of the war.

DEPARTMENT OF DEFENSE PHOTOS



Although military satellite images were not released, the civilian Landsat showed smoke from burning Kuwaiti oilwells (left and above), and an oil slick (in red) off the coast.



EOSAT PHOTO

battlefield, with himself at the center and the relative position of radars shown around him. Thus, the trackee becomes the tracker.

Radar location information is fed to High Speed Anti Radiation Missiles, or HARMs, the Weasel's main weapon. The pilot then maneuvers to get within the missile's firing envelope, and lets fly. While the missile homes in on the radar's signal, the aircraft veers away in evasive maneuvers.

Of course, it seldom comes off this neatly, for while the F-4G is trying to draw a bead on the radar, the radar is trying to guide surface-to-air missiles against him. "It's a gut shot between the radar operator and the Weasel," says Maj. Jim Howard of TAC. If the radar operator keeps transmitting long enough to bring a SAM to bear, the HARM may hit him. Conversely, if the Weasel pilot gets close enough to launch a HARM, a SAM may already be on the way to take him out.

Still, it beats the old ways of the Vietnam War, when as Maj. Howard recalls, F-4Cs would fly around until they got shot at, then try to outmaneuver the missiles and follow their smoke trails back to bomb the launchers. In fact, so effective were the F-4Gs in Desert Storm that the Air Force has shelved earlier plans to retire them before a new F-16-based Weasel can be fielded.

Tactics for technology

Devising the tactics that combine the elements of electronic war into an effective force is a monumental task. Jammers, air-defense suppression aircraft, attack planes, fighters and aerial refueling tankers all have to be assembled into cohesive fighting groups. These must be armed with the ordnance suited to their objectives, informed of the latest intelligence relevant to their mission, and their actions must be coordinated down to the second.

The amount of information to be tamed in flying the typical 2000 sorties a day was truly mind-numbing. Gen. Charles Horner, the Central Command's air commander, described the job saying, "A lot of computers bring together the tens of thousands of minute details—radio frequencies, altitudes, tanker rendezvous, bomb configurations, who supports whom, who's flying escort." The result goes into a daily 600-page computer printout called the Air Tasking Order, or ATO, which was distributed to every allied air base. Gen. Horner compared it to a single sheet of music ensuring that "everyone sings the same song."

Creating the ATO was the primary job of roughly 100 people working at computer terminals in an inflatable tent known as the Tactical Air Control Center (TACC), or less formally as "The Bubble."

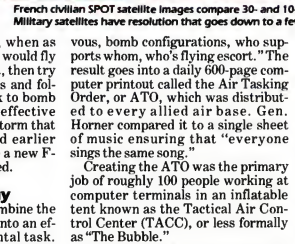
With the day's ATO in the field, there remained plenty of work to be done. Progress had to be tracked, unexpected contingencies responded to, and coordination maintained. Performing much of this work were aircraft known as ABCCCs, or Airborne Battlefield Command Control Centers. Consisting of conventional C-130s with a 47-ft.-long command capsule installed, the ABCCCs served as a sort of forward extension of the TACC.

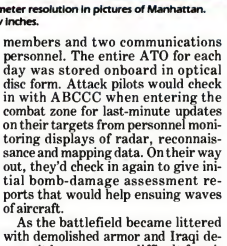
Front office

In its latest configuration, the ABCCC III (see Tech Update, page 33, Nov. '90), the aircraft contains computer consoles for 10 battlestaff members and two communications personnel. The entire ATO for each day was stored onboard in optical disc form. Attack pilots would check in with ABCCC when entering the combat zone for last-minute updates on their targets from personnel monitoring displays of radar, reconnaissance and mapping data. On their way out, they'd check in again to give initial bomb-damage assessment reports that would help ensuing waves of aircraft.

As the battlefield became littered with demolished armor and Iraqi decoys, it became more difficult for pilots to find fresh targets. One solution

(Please turn to page 111)





French civilian SPOT satellite images compare 30- and 10-meter resolution in pictures of Manhattan. Military satellites have resolution that goes down to a few inches.

SPOT IMAGE CORP. PHOTO

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ROAD WORK

Call anywhere, send faxes and receive data from your mobile office.

BY MICHAEL J. McDERMOTT

● Imagine driving as a waste of time. For those on life's fast track, time spent in a car is time spent out of touch with the rest of the world. "The currency of the 1990s will be time," observed one corporate executive recently. For those interested in saving time, the mobile office is like a savings account with a high interest rate.

For those highly motivated indi-

The road warrior at work. The cellular telephone is linked to a portable fax machine and an electronic organizer packaged in a briefcase.

PM PHOTO BY ROBIN ROSS; COURTESY MOBILE ELECTRONICS MAGAZINE

$1195.00 From April 1991
(Double Spread)

viduals, and for other quire they be physically separated from their offices for long periods of time, the age of truly portable communication has arrived. A collection of products already on the market—and a raft of new ones arriving all the time—makes it possible for today's road warriors to use their cars' cellular telephones to perform just about any function that can be done in a modern office.

Using equipment that marries cellular phone technology with computer capability, a traveling sales representative can transmit and receive orders and product specifications between his laptop and his company's host computer. Busy executives can now write memos in their cars and fax them all over the world. On a more lifesaving note, emergency response teams can punch up the medical histories of accident victims.

There will be an estimated 7 million cellular phone users in the United States by the end of this year, according to telephone company projections. Average cellular telephone costs are just a few hundred dollars, with some stripped-down models selling for less than $100. Along with the low price, improved service is attracting new users and is making the mobile office concept practical. The glitch rate of problems affecting cellular phones has dropped from one in seven calls in 1984, to about one in 500 today.

Cellular service levels should improve even more dramatically in the very near future with the advent of digital networks. Two new technologies—time-division multiple access (TDMA) and code-division multiple access (CDMA)—hold out over existing analog

The first generation of TDMA, which has already gone through the telecommunications industry standards approval process, offers three times the capacity of the current analog system. Further refinements will result in even more signal-carrying capability. One company has begun testing a version with 15 times the capacity of analog.

CDMA, a technology developed by San Diego-based Qualcomm, Inc., claims 20 times the capacity of analog in its first-generation system. Although it has yet to go through the industry standards approval process, big cellular carriers such as Ameritech and NYNEX Mobile Communications are very interested in it.

Ricoh's tiny fax machine fits snugly into a corner of your briefcase.

While the increased capacity offered by digital cellular networks will be a boon—especially for car-phone users in such cities as Los Angeles and New York, which frequently suffer from cellular gridlock during prime commuting hours—it promises other service improvements to the nation's road warriors. Since mobile office equipment will be able to tap directly into high-end digital-based services such as ISDN, error rates in fax and data transmissions will be greatly reduced.

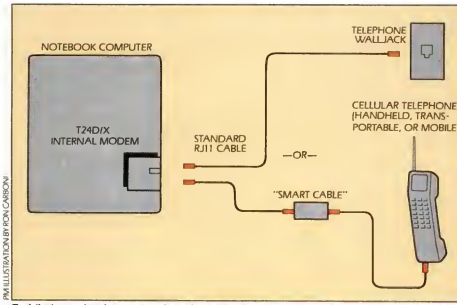
Would-be road warriors have several options in setting up their mobile offices: You can assemble your own system using a conventional landline modem, you can opt for equipment specifically designed to work with a cellular telephone, or you can choose one of the integrated packages that bundles a laptop computer with all the required cellular communications hardware and software.

Most laptop computer makers—including Toshiba, NEC, Zenith and Compaq—design their machines with space for an internal modem. An increasing number of models include a modem—and sometimes even a fax board—as standard equipment, but virtually all offer Hayes-compatible 2400bps modems as an option for prices ranging from $350 to $600.

Third-party suppliers can offer cheaper alternatives. Megahertz Corp., for example, makes internal modems and other laptop enhancement products compatible with all the major models. Prices range from $199 for a 2400bps internal modem to $599 for an internal 9600bps fax/2400bps modem board. Holmes Microsystems offers a similar lineup.

One disadvantage of internal modems for mobile-office users is that most draw battery power from the laptop, even when they are not being used. Portable external modems, powered by a standard 9-volt battery and about the size of a cigarette pack, are a good alternative. Touchbase Systems offers WorldPort 1200 ($199) and WorldPort 2400 ($359), which plug into any serial port.

The core of the mobile office is the laptop computer. As has been the case in so many other areas of electronics technology, laptops are becoming even smaller, lighter and cheaper. The latest generation, dubbed notebook PCs, can weigh 5 pounds or less (compared to 12 or 14 pounds for most laptops), are priced from $700 to $5000 and often include a modem as standard equipment.



PMI ILLUSTRATION BY RON CARSON

Toshiba's notebook computer includes an internal modem that allows for easy communications via either cellular or landline phone systems. All you need is the proper cable.

PM PHOTO BY BILL OGLE

Depending upon the type of equipment, you may need an acoustic coupler that wraps around the handset of the cellular telephone for data transmission.

Notebook buyers have no lack of models to choose from. Well-known names like NEC, Panasonic, Sanyo, Sharp, Tandy, Toshiba, Zenith and others are also players in this market. Toshiba, in fact, includes an internal modem with its laptop computers. Dubbed the T24D/X, it's designed for both cellular and landline communications.

Spanning the gap

The tricky part of mobile computing is spanning the gap between the cellular telephone-equipped vehicle and the landline infrastructure. Tapping into the landline system is generally done via an RJ-11 phone jack, but many cellular phones don't have one. The road warrior needs an interface device, either an acoustic coupler or a direct-connect jack.

Acoustic couplers fit over the handset of most telephones, including cellular models. The couplers are available at electronics retailers such as Radio Shack, but you may still need a connector to hook the modem to the coupler. Computer Products Plus offers a line of Road Warrior Toolkits that include a collection of adapters for that purpose. The kits are priced from about $50 to $280.

A better way to link a computer or fax machine to a cellular phone is with a direct-connect jack. There are two types. A simple jack provides the dial tone that is missing from a cellular phone but which is necessary to make data communications equipment work. While it supplies the necessary signaling capability, it cannot handle advanced features like auto-dialing or auto-answering. Simple jacks retail for around $200.

The briefcase of the future will hold a laptop computer, fax machine, phone and printer.

A "smart" jack allows you to use your computer or fax machine's auto-answer and auto-dial features by providing an off-hook tone that lets the data equipment know if the telephone is ready to receive. It also provides a dial tone for the RJ-11 jack, allowing you to hook up an answering machine or other telecommunications device. The smart jack also produces the tones required to make credit-card calls and access electronic information services. Prices are in the $400 to $500 range.

Some faxaholics just can't bear to be out of reach of their facsimile transmission machines even for a short time, and now they never have to be. Portable fax models come in a variety of configurations and range in price from about $600 to about $2300. The smallest of all is Ricoh's PF-1, which the maker boasts has won a spot in *The Guinness Book Of World Records* for its diminutive size. It weighs just 5½ pounds and measures 11 × 7 × 2 in. The unit can run off a rechargeable battery pack, a car's cigarette lighter or standard AC current. Not quite so small is its price tag, a hefty $1695.

For those looking to set up a complete mobile office in one fell swoop, several companies offer bundled systems with cellular phone, computer, fax machine and all the required communication link-up equipment in a single carrying case. Offerings include Spectrum's LapPak, Intelligence Technologies' ITC 386 XCEL and Secure Technologies' Portable Cellular Workstation. Expect to pay anywhere from $4500 to more than $8000 for these systems. If you already own much of the gear you need, you can buy just the briefcase from companies like Innovative Manufacturing Corp. One Softcase model made by Innovative can fit a laptop, printer, fax machine and cellular phone into its various cavities. Such cases may be the office briefcases of the future.

Avoiding problems

Fax and modem transmissions are also vulnerable to the fading and signal noise often associated with cellular hookups. Those glitches can distort or destroy data. Data can also be damaged during the switch from one cell site to another.

Spectrum is addressing this problem with a cellular operating environment called SPCL. It includes an error-correcting protocol and the technology for interfacing with and controlling the cellular phone. SPCL is available to users of Spectrum's BridgePlus modem, and the technology has been licensed to a number of laptop computer makers.

Another cellular error-correction protocol is MNP, which is incorporated in some laptop internal modems and in the products of many third-party modem suppliers. PM

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COMPARISON TEST

ELECTRIC DRILLS

Need a new drill? Here's what we think about 10 of the best.

BY THOMAS KLENCK,
Associate Home Improvement Editor
PM Photos by Stan Silver

● There are tools that you might like to own but never get around to buying, and there are tools that you simply can't live without. Within the latter group, there's one tool that stands out as the basic power component of every toolkit—the electric drill.

It's not difficult to explain why. In a world where tools are designed for specialized tasks, the drill stands out as a true jack of all trades. You'll not only use it for boring holes in materials ranging from concrete to metal and wood, but you'll drive screws and nuts, wire-brush away rust or paint, drum-sand contoured edges, stir paint and, with a small earth auger, even help out in springtime bulb-planting chores.

Power drill capacity is designated by the maximum-size shank that the chuck can accommodate. The three most common sizes are ¼, ⅜ and ½ in. Although chuck capacity does provide some indication as to what the tool can handle, drill bits are available with step-down shanks to increase the capacity of the smaller tools.

Our comparison test focuses on the most popular class of portable power drills—the ⅜-in. VSR (variable-speed, reversible) design. For most situations, it represents an ideal compromise in terms of power, weight and ease of handling. Manufacturers usually offer this tool in two models that differ primarily in their top speeds. Higher-speed tools (0 to about 2000 rpm) are better at han-

AEG BE 10RL

BOSCH 1022VSR

MILWAUKEE 0224-1

RYOBI D-1010

SEARS 10403

dling relatively small holes in wood. We tested the lower-speed-range units (0 to about 1200 rpm) designed to handle large-diameter holes and metal drilling.

In addition to chuck size, most manufacturers specify maximum capacities in wood and metal (see Specifications Chart on page 58). For the most part, these figures are useful only in comparing two drills of the same make—where a consistent standard is used for each tool. Many of the tools that we tested could clearly be pushed beyond their specified limits.

Makers also specify amperage ratings that indicate maximum electrical current usage. While these figures generally correspond to actual power output, you may find that a tool of lower amperage actually outperforms a slightly higher-rated tool (see Comparison Chart on page 59).

Although all of our test tools feature ball bearings and needle or roller bearings, some of the units exhibited side-to-side looseness, or radial play, at the chuck. Given the type of work that these tools are designed to handle, this may not be much of a problem. However, we wonder whether a sloppy bearing isn't the result of designing a tool via an accountant's balance sheet rather than at the drawing board.

Only the Porter-Cable, Ryobi, Milwaukee, Skil and Sears come with an auxiliary handle—an important accessory for heavy-duty hole boring. And, three of the 10 units (Hitachi, Makita and Ryobi) come with a clip for holding the tool on a belt. However, one feature that we found sadly absent on all but two of the tools (Hitachi and Sears) is a speed dial that permits the trigger to be locked at any point in the speed range.

Our tests highlight ease of use, handling, power and the various features found on each drill. And, just to keep these tools in proper perspective, we checked out a few of the many variations in portable power drills (see "Alternative Drills" on page 60).

AEG BE 10RL

The AEG entry is noteworthy if only because it ranks near the top of most of our specification categories. This 5-amp tool has the highest top speed (1400 rpm) and a healthy stated woodboring capacity of 1½ in. Its cord is the longest in the group and the heaviest—it's made with 16-gauge wire instead of the 18-gauge wire that supplies power to the other drills.

Although it's the longest tool in the group, it feels well balanced and is below average in weight. We especially like the oversize, easy-to-handle chuck key, excellent trigger and good brush access.

Surprisingly, the AEG drill was not at the top of our power trials, although this may be the result of the slightly higher top speed. The FORWARD/REVERSE switch is a sliding affair that goes through the handle and is operated from each side. It works, but it's not as convenient as the trigger-mounted switches found on some of the other drills. The AEG can be fitted with an optional auxiliary handle.

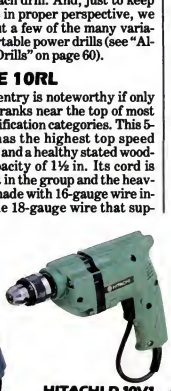
Black & Decker 1179

In terms of power, this drill is rated to draw a maximum of 4½ amps, and we found it placed just below the top three in hole boring and heavy screwdriving jobs. Its power-to-size/weight ratio is impressive—unfortunately, so is the tool's noise level.

The variable speed is very easy to control—especially in the low range—and the FORWARD/REVERSE lever is conveniently mounted directly below the trigger. However, where most of the other drill chucks are rat-

BLACK & DECKER 1179

MAKITA 6510LVR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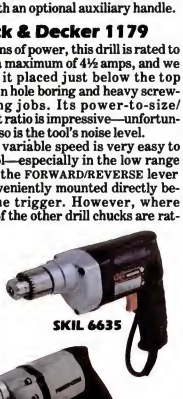
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PORTER-CABLE 7511

ed at a minimum opening of 0 to 1/32 in., the B&D drill has a chuck that only handles bits as small as 1/16 in.

The most disappointing feature is the trigger-lock button. It's not a button at all, like most of the units, but a sliding switch that's set in the handle under the trigger. Locking the tool on is an annoying 2-handed operation.

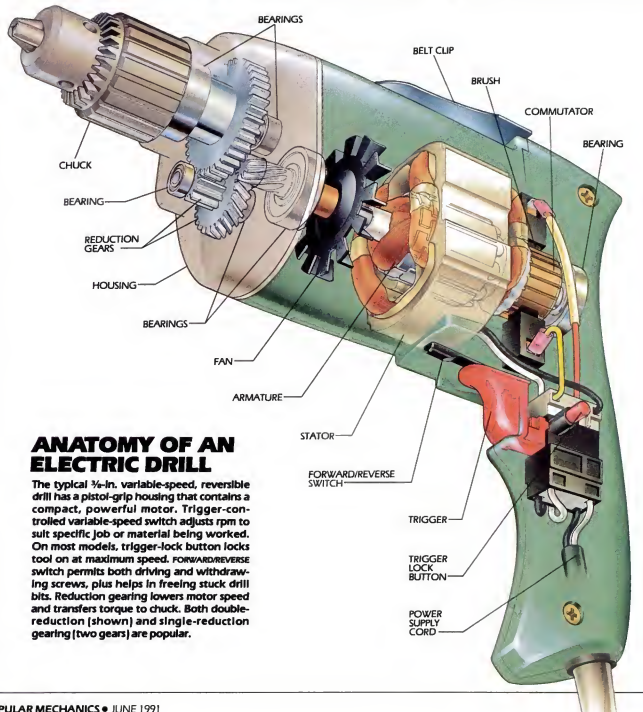
Bosch 1022VSR

Bosch offers five new 3/8-in. drills, all based on this design and motor. Each model differs from the next by either chuck size (light, medium or heavy duty), speed range (1100 or 2100) or cord material (PVC or neoprene). With the largest chuck and a low-speed range, our 1022VSR is at the heavy-duty end of the group.

By our standards, this is a very powerful drill. And, its trigger-controlled variable speed progresses smoothly through its entire range without a hint of roughness in the trigger mechanism or motor. The trigger-lock button is positioned for easy use and sits inside a raised rim so it's not inadvertently engaged. The FORWARD/REVERSE lever is mounted above and in front of the trigger—just where we'd like to see it.

While you might think that excellent power and one-handed fingertip control would be enough, Bosch has gone one step further by making a drill that's clearly the quietest in its class. What the sound level meter can't measure, however, is the quality of sound—the 1022VSR simply purrs when you pull the trigger. Bosch provides a chuck key holder that's molded into the cord near the handle.

We would like to see a speed dial so the trigger could be locked at any speed. A provision for an auxiliary handle wouldn't hurt, and that 6½-ft. cord is a little skimpy. And, the extra-heavy chuck makes the tool slightly nose heavy. If that's a concern, however, you can always drop about 6



ANATOMY OF AN ELECTRIC DRILL

The typical ¾-in. variable-speed, reversible drill has a pistol-grip housing that contains a compact, powerful motor. Trigger-controlled variable-speed switch adjusts rpm to suit specific job or material being worked. On most models, trigger-lock button locks tool on at maximum speed. FORWARD/REVERSE switch permits both driving and withdrawing screws, plus helps in freeing stuck drill bits. Reduction gearing lowers motor speed and transfers torque to chuck. Both double-reduction (shown) and single-reduction gearing (two gears) are popular.

PM ILLUSTRATION BY EUGENE THOMPSON

Chuck key holder on Bosch (shown) and Makita permits key removal. On other models, key is attached to cord by strap.

Trigger-lock button is usually under right thumb—lefthanded use is difficult. Note speed dial in trigger (Hitachi and Sears only).

Trigger-mounted FORWARD/REVERSE switch is best choice for driving screws where direction must be reversed frequently.

ounces of chuck by choosing the model 1021VSR.

Hitachi D 10V1

Of the tools in the 4-amp-and-below range, the Hitachi stands out with a few very special features. Like the Ryobi and Makita, this drill comes with a belt clip. However, it's removable and bolts onto the tool side. This position makes much more sense than the top-mounted clips on the other tools. And, although an auxiliary handle doesn't come with the drill, you can get one—it threads in place of the belt clip bolt.

The Hitachi also has a trigger-mounted speed dial that allows you to lock the trigger at any place in the speed range. It's a simple mechanical device that limits the maximum travel of the trigger. It's rather small and not the easiest thing to adjust, but it's definitely a valuable feature.

A very handy lock button, acceptable trigger and nicely designed handle make for a comfortable tool. The FORWARD/REVERSE switch, however, is at the top back of the handle—it's a 2-handed job to switch the direction of rotation. Although you'll get used to it, repeatedly driving and withdrawing screws will be more of a hassle than it should be. The plastic-sheathed power cord could be improved, as well.

Makita 6510LVR

Makita's entry is a no-frills version that appears well built, while somewhat lackluster. We liked the fact that the tool is held together with nuts and bolts—not the usual self-tapping screws. And, it's a compact, well-balanced drill that's a little lighter than average—a bonus if you're using the tool all day. Makita's built-in belt clip is positioned on the top, which makes the handle stick out from your body when the tool is on your belt.

The cord is plastic sheathed and has an integral molded chuck key holder similar to the Bosch. Unfortunately, plastic is not as good a material for the job as Bosch's neoprene. There's no facility for a side handle—an acceptable omission as this tool, like the other Japanese drills, is relatively underpowered. We found the trigger/handle configuration less comfortable than most units.

Earlier model versions came with a speed dial for locking the variable-speed trigger at any position. For some reason, Makita has dropped this feature, along with a heavier chuck and rubber cord. Like Hitachi, Makita believes that the FORWARD/REVERSE lever should be as far away from the user's fingers as possible. On this tool, it's at the bottom of the handle.

Milwaukee 0224-1

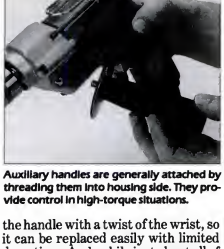
The 0224-1 belongs to Milwaukee's Magnum line of drills. The most distinguishing feature of this design is the oversize trigger that extends almost the full inside length of the handle. Not only is it easy to grip and operate, with almost any configuration of fingers, but Milwaukee has engineered the trigger travel so that speed control is smooth and effortless—even at the slowest speeds.

Along with a heavy-duty chuck, rugged construction, and solid feel and sound, this drill boasts a few extra-special features. First, it comes with a removable power cord—a quality, rubber cord that can be taken off

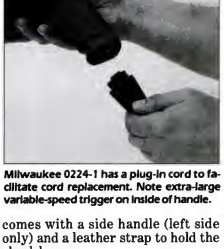
3/8-IN. VARIABLE-SPEED, REVERSIBLE DRILL SPECIFICATIONS

MANUFACTURER	MODEL	AMPS	WOOD CAPACITY[1]	METAL CAPACITY	TOP SPEED (rpm)[2]	SPEED DIAL[3]	LENGTH[4]	WEIGHT (lb.)	CORD LENGTH	PRICE[5]
AEG	BE 10RL	5	1½"	3/8"	1400	NO	10¾"	3.5	10'	$189
Black & Decker	1179	4.5	1¼"	3/8"	1200	NO	10"	4	8'	$138
Bosch	1022VSR	4.8	1"	3/8"	1100	NO	10¼"	3.7	6'6"	$187
Hitachi	D 10V1	3.3	1"	3/8"	1100	YES	10"	3.3	8'3"	$148
Makita	6510LVR	3	¾"	3/8"	1050	NO	10"	3.3	9'	$145
Milwaukee	0224-1	5.4	1½"	3/8"	1200	NO	10½"	4.75	8'	$189
Porter-Cable	7511	5	1¾"	3/8"	1000	NO	10"	4.5	10'	$200
Ryobi	D-1010	3.3	1¼"	3/8"	1300	NO	9½"	3	8'8"	$179
Sears	10403	3	1¼"	3/8"	1200	YES	10¼"	5.4	10'	$66.28
Skil	6635	5	¾"	3/8"	1200	NO	10¼"	4.84	8'	$173

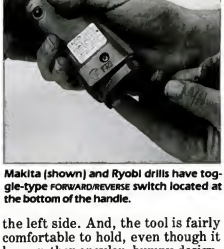
1. Maximum hole sizes in wood and metal as stated by the manufacturer. 2. Speed range of all drills starts at 0 rpm and is variable up to top speed. 3. Speed dial allows trigger to be locked in the ON position at any point in speed range. 4. Overall length from end of chuck to end of handle. 5. Suggested retail price as supplied by the manufacturer—for comparison purposes only, as tools frequently sell for less.



Auxiliary handles are generally attached by threading them into housing side. They provide control in high-torque situations.



Milwaukee 0224-1 has a plug-in cord to facilitate cord replacement. Note extra-large variable-speed trigger on inside of handle.



Makita (shown) and Ryobi drills have toggle-type FORWARD/REVERSE switch located at the bottom of the handle.

the handle with a twist of the wrist, so it can be replaced easily with limited downtime. And, while just about all of the tools offer some means for replacing the brushes, this tool has a brush cartridge system that's designed for fast brush replacement—you don't have to take half of the tool apart for simple maintenance.

Unfortunately, there are a few features that just don't come up to par. The tiny trigger-lock switch, found under the housing in front of the trigger, is ridiculously small and difficult to operate. And the FORWARD/REVERSE switch, while well located in front of the trigger, is too small and sticky in operation. The drill comes with a side handle that can be mounted on either side, and requires a grounded, 3-prong receptacle.

Porter-Cable 7511

In the 7511, P-C has a very serious drill that ranks at the top for power, while being compact, well balanced and comfortable. Its stated wood boring capacity is 1¾ in., the highest in our test group, and actual performance confirms this ranking. The tool comes with a side handle (left side only) and a leather strap to hold the chuck key.

This tool might very well have been our favorite if it weren't for a few less-than-perfect details. The action of the trigger isn't as smooth as the best, which makes variable-speed control rougher and more uncertain. And, the FORWARD/REVERSE switch, well placed over and in front of the trigger, is on the small side. Brush access is apparently not a priority, and P-C recommends that you get the tool to a service center when the brushes need to be replaced. Of course, you can do the job yourself—it's just not designed to be easy.

Ryobi D-1010

This drill has several of the features that the Makita and Hitachi units boasted. The belt clip is a wire version that's located on the top of the tool similar to the Makita. And, like the Makita, the FORWARD/REVERSE switch is located at the bottom of the handle—well out of the way.

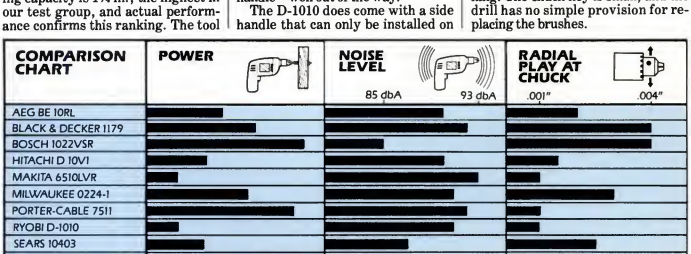
The D-1010 does come with a side handle that can only be installed on the left side. And, the tool is fairly comfortable to hold, even though it has a rather angular, bumpy design. The short 6½-ft. power cord is plastic sheathed. For its limited power, it ranks high on the noise-level chart.

The brushes are easily accessible for replacement. Upon separating the handle, however, we found that the switch and wires were a little less neatly packaged than in some of the other tools.

Sears 10403

This is the only drill in our group that features the midhandle position—Sears doesn't offer a drill of its own in the rear-handle format. Naturally, the tool is well balanced. It's also fairly comfortable to hold, and has a well-positioned, trigger-mounted FORWARD/REVERSE switch.

This is clearly the economy drill in the selection. Although the business end of the light-duty chuck runs fairly true, the chuck's tightening collar clearly wobbles when the tool is running. The chuck key is small, and the drill has no simple provision for replacing the brushes.



Power is determined by measuring maximum penetration depths at motor stall point while driving lagscrews into oak, and through subjective evaluations during end-grain and face-grain hole-boring tests with auger and twist bits. Noise level as measured in decibels (dbA scale) of free-running drill without bit. Radial play at chuck indicates side-to-side looseness as measured with a dial indicator.

$1770.00 —IAL

Alternative Drills

● Of course, the standard pistol-grip drill isn't the only way to bore holes. Like all other tools, there seem to be an endless number of variations that ensure you'll have the right drill on hand no matter what the job.

One of the most unique-looking models is the Sioux 8000 (top right, about $187). This drill, patented in 1938, features a motor and housing that's at a 55° angle to the chuck axis. You grip the tool right below the chuck where there's a large, lever-type trigger. While it's one of the best drills for working in confined spaces, you'll also find it a well-balanced comfortable tool in ordinary boring and screw-driving operations.

The standard tight-space boring solution is the right-angle drill. The Porter-Cable 7557 (middle right, about $275) is a ⅜-in. model with electronic variable speed. Right-angle drills are also available in heavy-duty ½-in. D-handle models. If you need right-angle drill capabilities but are unsure that you need a dedicated tool, right-angle drive attachments are available from most manufacturers. These are usually geared so that reversing them end for end in the drill provides a second speed range.

When it comes to boring a hole in concrete, you may make some headway with an ordinary drill and carbide-tipped masonry bit. However, if you really want results, use a hammer drill. This tool works like an ordinary drill, but, at the flip of a switch, enhances the rotating action with a pulsating, up-and-down hammer action. The Freud P20/2RE (bottom right, about $236) is a ½-in., 2-speed, variable and reversible model that delivers up to 42,000 hammer blows per minute at 3000 rpm. For real heavy-duty boring, rotary hammers are available. Many of these permit combined rotary/hammer action, or hammer action alone.

Unless you're a plumber or have been around the construction trades for long, that monster at the bottom center may look like a prop for a science-fiction movie. The truth, of course, is a lot simpler. It's Milwaukee's Hole Hawg 1675-1 (about $399), and its job is to bore holes in studs, joists and other framing where no other heavy-duty drill will fit. The 2-speed model shown spins at either 300 or 1200 rpm and handles up to 4⅜-in.-dia. self-feeding bits at the slow speed. A single-speed model (No. 1670, 1, 900 rpm) is also available.

There are times, of course, when all you need is a big drill—plain and simple. In these situations, you'll probably end up using something like the Ryobi DH-130 (bottom left, about $260). This single-speed brute spins bits at 500 rpm and can handle up to 3-in.-dia. holes with a self-feeding bit. Its spade-type rear handle is directly in line with the ½-in. chuck for transmitting force effectively. And, the top-mounted auxiliary handle provides control in high-torque situations. —*T.K.*

SIOUX 8000

PORTER-CABLE 7557

RYOBI DH-130

MILWAUKEE 1675-1

FREUD P20/2RE

The Sears model does come with a side handle that can be fitted on either side. And, it's the only unit other than the Hitachi that has a speed dial on the trigger for setting lock-on speed. In terms of power, this drill compares with the Japanese models—fine for light- and medium-duty tasks, but little reserve power.

The real attraction of this tool, of course, is its price. However, if you comparison shop through mail-order tool catalogs, you may find that the price differential isn't quite as great as it appears.

Skil 6635

If power is a priority, then put the Skil 6635 on your list of drills to take seriously—this is a tool with torque. It's also fairly comfortable and boasts a few unique variations on the standard drill features. The FORWARD/REVERSE switch is mounted on the motor housing side. It's basically a sliding switch that can be operated from either side of the drill. While the trigger-mounted switches are probably handier, Skil's solution works well and is easy to get used to.

The tool comes with an auxiliary handle. However, it's the type that mounts behind the chuck via a ring-clamp mechanism. With this design, you can adjust the radial angle of the handle to suit the job at hand. Trigger control is excellent, the trigger-lock button works well, and the tool has fairly good brush access. The only real problem with this tool is that it's loud.

Making A Choice

There are no failures in this group of drills—they all do what they're supposed to do. And although each maker's solution to the ⅜-in. VSR design problem varies, it's easy to get used to any of these units. Our all-around favorite is the Bosch 1022VSR. It's simply smooth, powerful and quiet with all the controls right at your fingertips. Porter-Cable and Skil are close runners-up and Milwaukee, Black & Decker and AEG fill in the middle. Of the less powerful tools—Hitachi, Makita, Ryobi and Sears—we opt for the Hitachi D 10V1. PM

$880.00

PLUMBING BASICS

USING LEAD-FREE SOLDER

BY MERLE HENKENIUS

● It's been more than two years since states began enforcing the federal EPA's ban on lead-based solders used in copper plumbing. Despite some initial grumbling by plumbers and homeowners, the Lead Contamination Control Act has brought solders into use that are a good deal stronger and better than the generations-old tin/lead standby.

As it turns out, the 50/50 tin/lead solder used for so long was not even made for the copper fittings used in residential plumbing. Plumbers found it was simply the easiest solder to use when the industry converted from galvanized iron to copper piping. Other solders were available then, and continue to be used now, as 50/50 substitutes. The most popular is a 95/5 mixture of tin and antimony (95% tin, 5% antimony).

The problem with using 95/5 or other hard blends is that they require greater skill. While the relatively soft, lead-based solders melt at 360° F, hard solders melt between 450° and 500° F. Higher melting temperatures mean a greater chance of cooking the flux from the joint and scorching the fitting. This means it's harder to make a water-tight fitting.

Moreover, hard solders don't "gap" as well. While soft solders slurp around a joint in a single, gap-filling motion, hard solders are runny and don't fill gaps very well, even though they make a stronger joint.

Fortunately, several manufacturers have come to the rescue with lead-free solders that are just as strong as traditional hard solders, but they melt at temperatures nearer those of soft solders. These solders contain a variety of substitutes for lead, including tin, silver, copper, nickel and antimony. While two to three times stronger than 50/50 solder, the new blends melt at a workable 400° F.

During your next plumbing job, you may be in for a surprise at the hardware store. The new lead-free solders cost nearly twice as much as 50/50 solders, owing to the more expensive metals involved (especially tin, which is quite expensive today).

PHOTO BY MERLE HENKENIUS

Lead-free solders melt at higher temperatures than the older, mostly lead types. Once you learn how to use them, you'll solder as much as you did before.

Expect to pay around $11 for a 1-pound spool. This expense is partly offset because the substitute metals are lighter than lead, so you get roughly 20% more solder per pound. Either way, this is of more significance to professionals who use large quantities of solder. Homeowners usually buy only one or two spools over many years.

So what do you do differently when working with high-temperature lead-free solders? Actually, not much. Since the new blends have slightly higher melting temperatures, spread the heat uniformly. While you might have gotten by with heating a fitting in one or two spots before, now you'll need to heat it from several directions, building up temperature progressively around the fitting.

With a little practice, you'll soon get the hang of working with these new solders. If you're unsure of your ability, solder together a few test joints from scrap copper first.

Assessing the lead risk

The EPA ban only affects new construction, but what about all those pre-1988 piping systems with lead-based solders? Should these systems be replaced? The reasonable answer is: no.

Simply having lead solder in your house's piping system doesn't mean that any of it passes through your faucets. Only a narrow ribbon of solder comes in contact with water at each joint, and even it may be sealed by mineral deposits and thus, rendered harmless. In fact, slightly hard water is your best friend when it comes to lead solder in your plumbing systems.

Keep in mind that millions of houses built 60 to 100 years ago actually had lead water-service pipes. A substantial percentage of those homes still do. Only the minerals precipitated onto these pipes keep them fairly safe.

As a general rule, soft water is more aggressive and will leach more lead from solder joints than hard water. We also know that the newer the solder joint, the more lead will be sloughed off. An older piping system is, therefore, safer than a newer one. And finally, lead will only leach out when water is allowed to stand for hours at a time. As such, your best bet is to let the water run a little, to flush standing water from the system, before taking your first drink in the morning.

A lead-testing kit

If you are concerned about the possible effects of lead contamination and aren't sure whether your water system was assembled with lead-based or hard solder, the Copper Development Association has created an easy-to-use test kit. You scrape a little solder from a fitting and drop it into the kit's solution. If the solution turns a frothy yellow, expect lead-based solder. Your other option is to have a lab test the water.

The kit is priced at $64 and is available from All Seasons Marketing, 3576 Wesley Chapel Rd., Marietta, GA 30062. PM

$2080.00 Double Spread

The original front porch, with tapered and chamfered columns, rich molding details and stately proportions, forms the inspiration for our reproduction back porch project.

The site before construction shows an extension on the right that abuts a bland expanse of wall. Proportions of the new porch are determined by existing rooflines and door and window heights.

HOME IMPROVEMENT

TRADITIONAL PORCH

When a deck just won't do, build a porch to match the house.

BY THOMAS KLENCK, Associate Home Improvement Editor

● There are two kinds of people who own traditional homes: those who have gracious, expansive porches, and those who wish they did. Unlike today's equivalent—the backyard deck—a traditional porch is an extension of your home's architecture. It not only reinforces design elements that define the house, but actually adds to and completes a visual theme. And, it's more than just a place to while away the hours on a warm summer afternoon, it's a vital year-round component that protects the house from the elements while providing a transition from the outdoors to the warmth and comfort of home.

If you're interested in adding a porch to your home, you may be disappointed to find out that there's no one design to meet every situation. Each porch, down to the last detail, must be appropriate to the house that it graces. However, most traditional porches share a common, underlying structure. And, the process of developing your own porch design, or duplicating an original porch, is the same no matter what style your home.

To get you started in the right direction, our porch combines many of the structural and design features characteristic of traditional structures. You may well not want to reproduce every detail, but our project is sure to inspire you to develop a customized version that suits your particular situation and requirements.

Our porch completes the back facade of a 100-year-old country home. It fits neatly in the corner created by the main structure and a kitchen extension. The basic look and molding details are taken directly from the original front porch of the home. However, the proportions were altered to suit the new location.

The porch features a typical sloped, tongue-and-groove floor; box-type posts complete with distinctive, yet easy-to-make, molding details; a hip roof; beaded tongue-and-groove ceiling; and traditional rails, balusters and newel posts. And, while we used modern materials and lumber, the construction is entirely in keeping with the spirit of the original front porch. Where heavy 4-in.-thick beams support and tie together our original model, we constructed up-to-date equivalents with 2 × 8s, construction adhesive and nails. And the old classically turned balusters were easily replicated with today's pressure-treated variety.

Before you begin your porch, plan the details such as moldings, post design, proportions, roof slope and rail design to suit your house. Then, have your design and framing details approved by your local building inspector, if required.

Color photos: Stan Silver
Black-and-white photos: Thomas Klenck
Technical art: Eugene Thompson

Our reproduction moldings capture the shape and depth of the originals, but are assembled from profiles made with a router.

The rails are made from ordinary lumber that's shaped to the original design. Balusters are standard pressure-treated type.

Box-type step construction matches original front porch, as does turned lower newel posts and square upper posts.

The Porch Floor

Although the original front porch was supported on posts that simply rested on flagstones, we opted for poured concrete footings set below the frost line. Begin by laying out the positions of the posts and the main front beam with stakes and string. Make sure that the post positions are evenly spaced and run parallel to the house. Then, dig holes for the footings. For concrete forms, use 10-in.-dia. cardboard construction tubes, cut to protrude a few inches above the grade. Plumb the tubes, backfill, and pour the concrete (Photo 1). Because the job is small, you can use bags of premixed concrete, prepared by hand or with a power mixer.

Next, strike a chalkline along the wall at the finished height of the floor, plus ½ in. Double-check the dimensions between the footing centers, and mark the corresponding post and crossbeam positions on the wall. We used a circular saw to cut our clapboard siding along the chalkline (Photo 2). After prying off the siding, slide aluminum flashing up under the siding to protect the sill and ledger from moisture. Fold up the flashing using a ¾-in.-thick board—held under the edge of the siding—as a spacer (Photo 3). The framing goes under the flashing and the flooring fits over it. If one end of your porch abuts a house wall, lay out the sloped floor line, remove the siding and install flashing in preparation for an end ledger.

Unless your porch is short, you'll need to make up the ledger from several lengths of stock. Plan the joints to fall between the crossbeam positions. Mark the crossbeam notches on the ledger stock and cut the notches with a sabre saw (Photo 4). Then, tack-nail the ledgers in place, check that they're level and secure to the house sill with ⅜ × 4-in. lagscrews and washers (Photo 5). Then, install the end ledger at the correct slope.

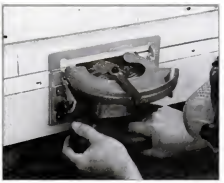
Next, cut the 6 × 6 post stock oversize in length, and cut a crossbeam for each post. Clamp or tack-nail each beam to its post, and use a line level to check that the beams are at the right height and slope. Then, mark the post notch lines under the beam edges (Photo 6), and cut the notches. Cut the inside main beam 2 × 8s to length, so their ends join on the post centerlines. Use a drill and sabre saw to cut the crossbeam mortises as shown, and test fit the inner main beam, single crossbeams and posts (Photo 7).

Cut the outer main beam pieces so the joints are centered between the posts. Then, assemble the doubled main beam with nails and construction adhesive. Cut the joist notches in the remaining crossbeam pieces by clamping them together, cutting several kerfs with a circular saw and removing the waste with a chisel (Photo 8). Then assemble each crossbeam.

Assemble the main beam, crossbeams and posts (Photo 9). Use carriage bolts, nuts and washers to secure the main beam to each post. Toenail the crossbeams to the rim joist and ledger. Double-check the spacing between crossbeams, and saw the joists to length. Cut the notches as shown, tap the joists in place, and toenail (Photo 10).

To protect the framing from moisture, we stapled a layer of roofing felt along all top edges (Photo 11). We used 1 × 4 tongue-and-groove fir porch flooring for the floor. Cut each piece oversize in length, and nail diagonally through the tongue with 6d galvanized finishing nails (Photo 12). Apply a coat of oil-based primer to the underside and edges of each piece. Trim the floor edge with a circular saw so it overhangs the main beam 1½ in. At the porch end, you'll need to install a temporary cleat to the end beam to support the last piece of flooring until the trim is installed. Then, prime the floor.

1 Use 10-in.-dia. cardboard concrete forms to pour footings below frost line. Premixed bags of concrete can be mixed by hand.



2 After striking chalkline ½ in. above floor level, remove clapboard with a circular saw set to cut only through siding.

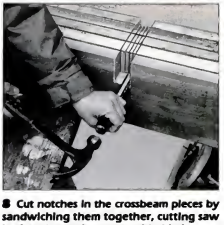
3 Slide flashing under siding, and bend so it will lie under flooring. The ¾-in.-thick spacer and 2 × 4 block shape bend.

4 After cutting ledgers to length, use a sabre saw to cut the 2½ × 4½-in. ledger notches at crossbeam locations.

5 After tack-nailing ledgers in place, check that they're level and bore holes for installing the ⅜ × 4-in. lagscrews.

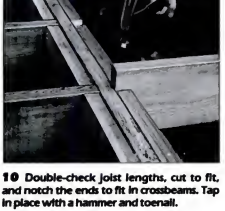
6 Temporarily nail or clamp single crossbeams at correct height to 6 × 6 posts. Mark the post notch line with square.

7 Test fit inner main beam with single crossbeams and posts. Then, add outer main beam with nails and construction adhesive.



8 Cut notches in the crossbeam pieces by sandwiching them together, cutting saw kerfs and removing waste with chisel.

9 Assemble main beam, crossbeams and posts. When all parts are aligned, bolt main beam to posts and toenail crossbeams.



10 Double-check joist lengths, cut to fit, and notch the ends to fit in crossbeams. Tap in place with a hammer and toenail.

11 With the framing complete, staple roofing felt strips over the upper edges to protect the wood from excess moisture.

12 Nail 1 × 4 tongue-and-groove flooring to framing. Priming bottom faces and edges increases the life of the floor.

Posts And Roof

The porch roof is supported by tapered, box-type posts, positioned directly over the 6 × 6 floor posts. Begin post construction by cutting 1 × 6 stock about 2 in. oversize in length. Mark the narrower top width of each piece on one end, and the wider width on the other. Note that each post is made up of two wide and two narrow pieces, each cut to the same taper. Tack-nail a straight 1 × 6 guide board to a post side, so the guide-board edge aligns with top and bottom width marks. Set the table saw fence to the guide-board width, and rip the taper on the post side (Photo 13).

After tapering all the sides, find the crosscut angle by first striking a centerline with a chalkline. Then, use a bevel gauge to mark the angled lines through the centerline that form an X. Adjust the bevel gauge across the bottom of the X (Photo 14), and use this angle to crosscut all post stock 1 in. oversize in length.

Shape the stopped chamfers on the wide post blanks using a router with a guide bushing, and ½-in.-dia. straight bit. Construct a jig to hold the router at 45° to the stock (see chamfer jig detail on page 68). Add small stopblocks as shown in the drawing to limit the length of the chamfers (Photo 15). Rout the bevels on one edge of each wide piece first. Then, shift the stopblocks to the opposite end for routing the other edge of the pieces.

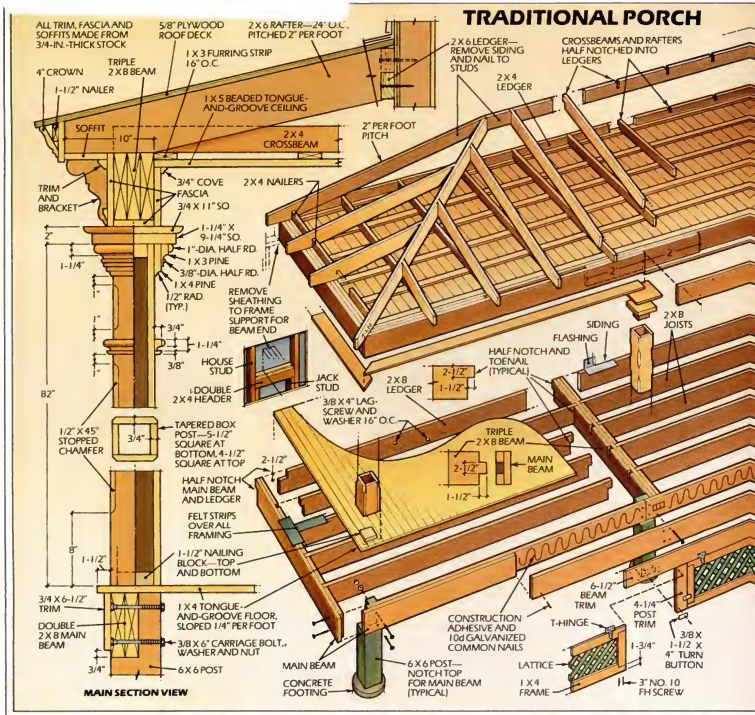
After the chamfers are cut, assemble each post with 6d galvanized finishing nails (Photo 16). Apply a thin layer of construction adhesive or waterproof glue to the joints before nailing, and set all nails.

The post crown moldings are made by assembling simple moldings fabricated with a router mounted in a router table. You'll need ½- and ⅜-in.-rad. rounding-over bits, a ½-in.-rad. cove bit and a ⅜-in.-dia. half-round (or edge-beading) bit. The cove in the 1 × 3 stock is cut with a 1-in.-dia corebox bit after rabbeting (Photo 17). Miter the moldings to fit, and nail with a little construction adhesive at each joint (Photo 18). Note that the mitered moldings are cut square even though the posts are tapered—the taper is not great enough to affect the joints significantly. With the molding in place around the posts, make the two square top pieces for each post. Use 5/4 stock for the lower component, and use a ¾-in.-rad. rounding-over bit on the edges of the upper ¾-in.-thick square stock. Nail these pieces together, and nail a centered 1½-in.-thick square to the bottom to fit inside the post top. When the posts are finished, apply a coat of oil-based primer and caulk the set nailheads. Then, cut the bottom of the posts to exact length and angle to match the slope of the porch floor.

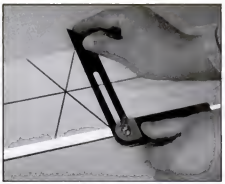
Find the center of each post on the floor, and nail a 1½-in.-thick × 3½-in.-sq. block at these locations (Photo 19). Then, place a post over its block and temporarily secure it with braces tacked to cleats nailed to the porch floor. Check for plumb with centerlines drawn along the post faces.

Before the main roof beam is installed, rip 1 × 6 stock to 4½ in. wide for the beam bottom trim. Cut this trim to length so the pieces butt at the center of each post top, and nail in place (Photo 20). Miter the trim at the corner post. Then construct the roof beam sections on the ground. Each section has two outer beams that butt at a post center, and inner spacers that overlap the joint at least 2 ft. Secure the main beam by nailing through the trim from below (Photo 21). Where the short end beam meets

$1510.00 Double Spread

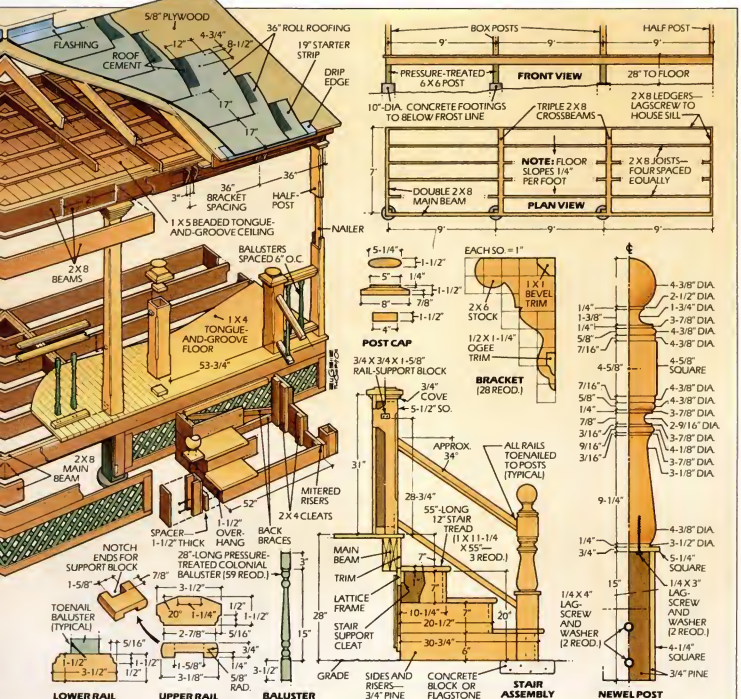


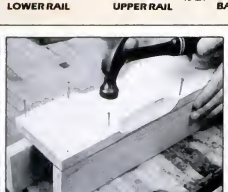
13 Tack a 1 × 6 to a post side so it's aligned with post taper. Hold the guide strip against the table saw fence to saw taper.



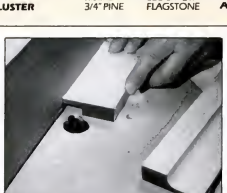
14 Find crosscut angle by first drawing centerline. Then, lay out X with bevel gauge. Angle is found from edge to edge at X.

15 Cut chamfers with router and straight bit. Jig holds router at 45°, and small stop-blocks shape chamfer ends.





16 Nail posts together with 6d galvanized finishing nails and waterproof glue. Set nailheads and cut the posts 1 in. oversize.



17 Shape all post moldings with router table and simple bits. Corebox bit shapes hollow after rabbet is cut on table saw.

18 Assemble moldings with finish nails and glue. Set nailheads, coat posts with oil-based primer and caulk nailheads.

$919.50

the house at the open end of the porch, remove siding and sheathing, and install support framing to the wall studs. Alternatively, you could use a half post as shown at the opposite end.

With the beam in place, the temporary post bracing can be removed. Use a chalkline to lay out the roofline along the house wall. Cut a pattern rafter from 2 × 6 stock, and use it to lay out the angled roofline at the hip end of the roof. Then, mark the ceiling line with a chalkline, and remove the siding that lies within the area where the roof and ceiling join the wall. Install flashing under the siding and fold it up so it's out of the way.

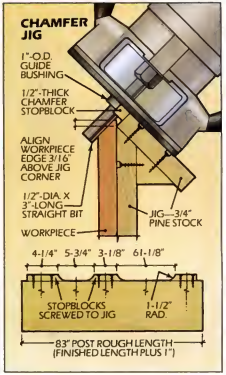
Cut the rafter notches in the rafter ledger, and nail it to the studs in the wall with 16d nails (Photo 22). Use the pattern rafter to lay out all of the rafters and the hip ledger. After installing the hip ledger to the wall, cut and install the hip rafter as shown. Toenail all rafters to the ledger and main beam (Photo 23), and fit jack rafters to the hip rafter as shown.

After the roof is framed, nail the ¾-in.-thick fascia to the rafter ends. Bevel the upper edge of this stock to match the roof slope—the lower edge extends below the rafters 1 in. Then, install the ⅝-in.-thick plywood roof deck with 4d galvanized nails. The crown mo[illegible]on next. Install a 1½-in.-thick nailer to support the molding. Where the molding must be joined, miter the ends to help conceal the joint line (Photo 24). After the crown is in place, install the roof beam fascia and the soffits.

We used roll roofing over the plywood roof deck. Install this following manufacturer's instructions. Use a notched trowel to apply the adhesive as each succeeding layer is nailed in place (Photo 25). Install the roofing under the flashing. Apply roofing cement between the flashing and roof.

Notch and install the ceiling crosstie ledger as shown in the drawing. Then, cut and install the 2 × 4 crossties. Note that the upper edge of one crosstie must be notched to accommodate the hip framing. At the end of the porch, toenail nailers between the jack rafters. Install 1 × 3 furring strips on 16-in. centers across the crossties. Then, nail the 1 × 5 beaded tongue-and-groove pine ceiling to the furring (Photo 26). Finish the inside by installing the inner beam fascia and ¾-in. cove around ceiling perimeter.

Make a template of the ornamental bracket, as shown. Lay out the shape on 2 × 6 stock and cut each bracket on a band saw. Install a pair of brackets 3 in. apart over each post (Photo 27). Then, evenly space the remaining pairs between the posts. Finally, make the beveled corner trim on the table saw, and install in the corner between the soffit and beam covering board. Then, rout and install covering board trim as shown in the drawing.

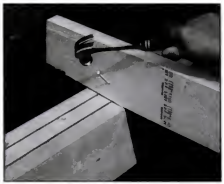


19 Lay out 6 × 6 post centers on floor, and nail 1½-in.-thick post block to floor. Then, install posts, plumb and brace.

20 Begin roof construction by nailing beam bottom trim to post tops. Butt trim at posts and miter at corner post.

21 Then, install triple-width beam in sections. Middle 2 × 8 spans joint. Nail from underneath and toenail to posts.

22 Nail notched 2 × 6 rafter ledger to house wall after removing siding. Note aluminum flashing bent up over ledger.



23 After cutting all rafters, toenail them to ledger and to main roof beam on 2-ft. centers with 10d galvanized nails.

24 When roof decking is done, nail crown molding in corner between deck and fascia. Miter joints between pieces.

25 Apply appropriate roofing adhesive with a notched trowel to secure each course of roll roofing to the last.

26 After 2 × 4 crossties and 1 × 3 furring strips are in place, secure 1 × 5 beaded tongue-and-groove ceiling with finish nails.

27 Install brackets in pairs over post centers. Then, space additional pairs evenly in between posts. Secure with finish nails.

Lattice, Steps And Rails

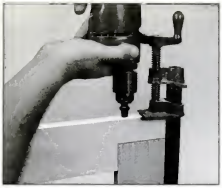
Build the lattice frames out of 1 × 4 stock. Notch the corners as shown in the drawing and join with 3-in.-long No. 10 screws. Bore counterbores for the screwheads about ¾ in. deep (Photo 28) and plug the holes after assembly. Cut each lattice panel 2 in. longer and wider than the inside dimensions of the lattice frames. Then, nail the lattice panels to the frames.

Install the main beam trim with galvanized finishing nails, and temporarily nail the completed lattice frames in place. Then, secure the T hinges as shown in the drawing, and remove the nails. The lattice frames behind the steps and at the end are simply nailed in place. After the hinges are secured, install the post trim (Photo 29).

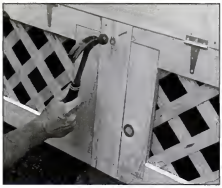
Begin the steps by ripping the side boards and risers to width, and miter the boards to length as shown. Then, use 2 × 4 stock to cleat the side boards together (Photo 30). After nailing from the 2 × 4 side, flip over the assembly and nail through the outside boards into the cleats. With each side complete, nail the mitered risers to the edges of the cleats (Photo 31). Finish the steps by installing the stair treads and back bracing.

Select the clearest and straightest 2 × 4 stock available for the rails. Rout an ogee molding along two edges of each piece on both upper and lower rails. Then, set the table saw to 20° and rip the bevels on the upper rails (Photo 32). Use a hand plane to smooth the rough-sawn faces.

Rip the underside component of the upper rail from ¾-in.-thick stock.



28 Use a clamp to hold lattice frame together when boring counterbored screw-holes. Then, install 3-in. No. 10 screws.



29 Install lattice frames with T hinges (except behind steps). Finish porch floor trim by nailing post trim in between frames.

30 Assemble mitered sides with 2 × 4s nailed in line with riser positions. Then, flip over and nail through into 2 × 4.

Round the edges by taking successive beveled passes with a hand plane and sanding smooth. Then, use a dado blade in the table saw to cut the ¼-in.-deep baluster channel in the underside of the bottom piece (Photo 33).

Screw a ¾-in.-sq. × 1⅝-in.-long rail-support block to each post and wall where a rail will be secured (Photo 34). Position the blocks 1½ in. below the height of the top of the rail. Then, after cutting the upper rail components to exact length, cut a notch at the ends of the ¾-in.-thick piece so that it fits around the support blocks. Nail the upper rail components together, slide in place over the support blocks and secure the assembly by toenailing.

We used standard, pressure-treated colonial-style balusters available at most building supply dealers. Cut all balusters to exact length. Then, determine the distance between each baluster by first estimating the number of balusters required between two porch columns. Multiply the baluster width (1⅝ in.) by the number of balusters and subtract this number from the distance between the columns. Then, divide the result by the number of balusters plus one. Cut a scrap spacer block to the length between the balusters.

To install the lower rail and balusters, cut the lower rail to a tight fit and tap in place. Position a baluster between the rails at each end. Then use a wedge to hold the lower rail against the baluster bottom while finishing nails are toenailed around the baluster. Toenail the bottom rail to

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the posts. As each baluster is added, move the wedge underneath for support and use the spacer block to locate the next baluster position (Photo 35). After nailing to the bottom rail, plumb each baluster and toenail to the top (Photo 36).

We made the newel posts at the bottom of the steps from solid 6 × 6 hardwood planed to 4⅝ in. square. If this size stock isn't available, you can laminate the blank from thinner lumber, using waterproof glue. Mark the center of the square faceted section on each face of the blank. Clearly lay out a full-width circle on each face at this center, and install the blank in the lathe. Start the lathe at its slowest speed, and observe the layout circles as the blank rotates—the area inside the circle will not be turned. Turn the area outside the circle down to a cylinder. Use a roundnose scraper and skew to carefully approach the circle line. Once that area is finished, shape the remaining details (Photo 37). At the ball end, turn the waste down to roughly 1½ in. diameter. When the post is finished, saw away the waste and shape the ball top with a sharp chisel and sandpaper (Photo 38).

Cut the pieces for the hollow newel post base, and assemble three sides and the top with finishing nails and construction adhesive. Secure each base to a post with 2¼-in.-dia. × 3-in.-long lagscrews (Photo 39). Secure the post assemblies to the steps by first nailing the post spacer in place as shown in the drawing. Then, lagscrew through the spacer and into the 2 × 4 cleat of the first step. Nail the remaining post base boards in place.

The upper newel post is a simple square box with stopped chamfers that match the main columns. Shape the beveled post top on the table saw, and mount a square 2 × 6 block to the lathe faceplate to turn the oval that's nailed on the post top. Then, toenail the rails and balusters in place.

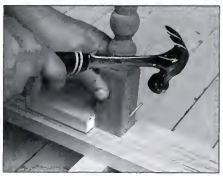
Paint the unprimed portions of the porch with oil-based primer, and then finish with at least two coats of a quality satin-finish latex paint. Use oil-based porch and floor enamel for the floor. **PM**

31 Nail mitered risers to 2 × 4 cleats with galvanized nails. Then, install back bracing and stair treads, and set all nailheads.

32 Make rails out of straight 2 × 4 stock. After routing ogee profile along two edges, bevel top rail tops on table saw.

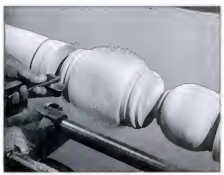
33 Round edges of top-rail bottom section with hand plane. Then, use dado blade in table saw to form baluster channel.

34 Screw rail-support blocks where upper rail meets posts or house walls. Slide rail assembly in place and toenail.



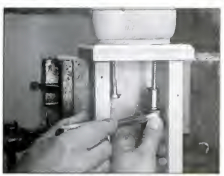
35 Use tapered 2 × 4 wedge under lower rail for support when nailing balusters. Spacer block holds baluster at correct spot.

36 Plumb each baluster with a level and toenail baluster to top rail. Set all nails and fill with caulk after priming.



37 Newel post is turned on lathe from 4⅝-in.-sq. hardwood. Blank can be laminated from thinner stock, if necessary.

38 After the post is removed from the lathe, saw off waste and trim top of post with sharp chisel. Then sand.



39 Attach each post to a base with two 3-in. lagscrews and washers. Leave off last side until assembly is attached to steps.

APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Frig Drips

Our Frigidaire, model No. FPI-19TKW, serial No. 20AD8538, drains water into the inside of the refrigerator, and we catch it in a bowl. I cleaned the drain pan under the refrigerator, and it shows no signs of condensate in it. The tube leading from the back of the refrigerator is not plugged. Any suggestions? EDMUND ZAWACKI
ST. PAUL, MN

The refrigerator's defrost drain hole at the back of the freezer is probably frozen shut, preventing the defrost water from draining. A frozen drain repair kit will correct this. The kit is Frigidaire part No. 5308950139 and is sold through WCI (White Consolidated Industries) parts distributors. Call (800) 451-7007 to locate a distributor near you.

Begin by unplugging the refrigerator and emptying it. Remove the plastic drain cup from the back wall of the refrigerator, the ice-cube trays and shelf, or the automatic icemaker. Unhinge the refrigerator and freezer door, and remove the breaker trim around the doors and the plastic mullion strip at the front of the freezer. Lift off the plastic freezer floor. Defrost ice on the divider block with a hair dryer. If the divider is soaked, replace it (part No. 5300170078), then reinstall the floor pan, doors and mullion strip.

Remove the freezer fan cover and the evaporator cover. Behind the cover is the evaporator fan motor assembly and wire plug. Remove these before lifting out the cover.

Next, lift up the evaporator coil and swing it to one side. (There are wires on the defrost heater that you may need to unplug before moving the coil.) Be careful when moving the evaporator to avoid breaking the tubing, which would result in a very expensive repair. Defrost any ice in the aluminum drain trough and then lift out the trough.

The frozen drain repair kit includes a flared copper drain insert and a piece of copper wire. Slip the drain insert into the hole in the divider block. Reinstall the drain trough. Swing back the evaporator, bend the copper wire into a shepherd's hook, wrapping the wire over the radiant defrost heater. Run the wire through the drain trough and into the copper drain insert. The wire conducts heat from the defrost heater through the trough into the drain, preventing it from freezing. Snip off excess wire hanging through the drain into the refrigerator compartment.

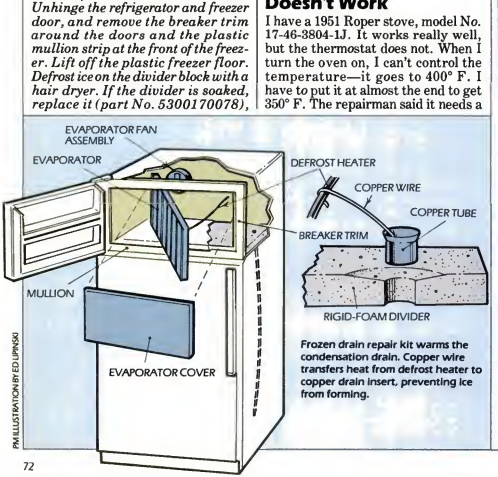
Thermostat Doesn't Work

I have a 1951 Roper stove, model No. 17-46-3804-1J. It works really well, but the thermostat does not. When I turn the oven on, I can't control the temperature—it goes to 400° F. I have to put it at almost the end to get 350° F. The repairman said it needs a new thermostat, but nobody has it. Can you help? RICARDO LIMAS SR.
EL PASO, TX

There is hope for your vintage range. A new thermostat is no longer available, but you can have your old thermostat remanufactured or a replacement thermostat installed.

First, remove the old thermostat. Write down any information you find on it, such as the manufacturer's name, numbers or letters. Next, call Repco Replacement Parts, Inc., in Everman, Texas, at (800) 433-7146. This company remanufactures both gas and electric thermostats. Supply the company with the information from the old control.

Repco will quote you a price for a remanufactured thermostat, if it has one in stock. If the information on the old thermostat is illegible, then you can send it to them with your name, address and phone number. Repco will inspect your old thermostat and call you with the cost to rebuild it.



PM ILLUSTRATION BY ED LIPINSKI

Frozen drain repair kit warms the condensation drain. Copper wire transfers heat from defrost heater to copper drain insert, preventing ice from forming.

Service Tip

It's estimated there are about 14,000 clothes dryer related fires every year in the U.S. Some fires are caused by a lint buildup in the filter or exhaust duct. When lint blocks the flow of air, excessive heat buildup may cause a fire in some dryers. To prevent fires, the Consumer Products Safety Commission suggests the following:

1. Clean the lint filter after each load of clothes. While the dryer is working, check the outside exhaust to make sure air is escaping.

2. Check the duct frequently if you have a plastic exhaust duct rather than a metal one. A corrugated plastic duct is more apt to trap lint in its ridges compared to a smooth metal duct.

3. Follow the manufacturer's instructions when installing a new dryer. Most manufacturers get their dryers listed by Underwriter Laboratories, which specifies the use of a metal exhaust duct (available at building suppliers). When having a dryer installed, insist on a metal duct, unless the installer has verified that the manufacturer permits a plastic duct. PM

DO YOU HAVE AN APPLIANCE PROBLEM? *Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.*

NEW PRODUCT

REUSABLE SANDING SHEETS

● Rinse 'n Reuse is a new sanding sheet made of cloth-backed aluminum-oxide grit bonded to a foam backing. We tested the sheets sanding flat and convex surfaces, and found they have a slight advantage over standard sandpaper on curved surfaces.

We used both products for the same amount of time and found that on a flat workpiece the wear was about equal. We repeated the test on a convex shape and found the foam-backed sheets to be slightly more durable.

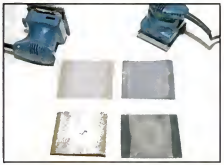
We suspect that when sanding a convex surface, the grits are quickly sheared off the face of regular sandpaper, but on the foam-backed paper, they are pushed into the backing, so they are less prone to being sheared off. This flexibility proved useful in sanding lathework (Photo 3).

Foam-backed sanding sheets are washable and can be used wet or dry on wood or metal.

The 9 × 10-in. washable sheets come in three grits: 60 coarse, 100 medium and 150 fine. A 2-sheet package costs about $3 at hardware stores. Write NicSand, Inc., P.O. Box 29480, Cleveland, OH 44129.

—Rosario Capotosto

1 Foam-backed and regular sandpaper were equally durable when used on a flat surface during 5-minute sanding test.



2 Top: equally worn sheets used on flat stock. Bottom: Foam-backed sheet (right) outlasted regular paper on curved stock.

3 The flexible abrasive sheet is ideally suited for sanding lathework. Here, one folded sheet sands cove on table leg.

TOOL TEST

NEW PLUG CUTTER

● With something as simple as a plug cutter, there seems to be little room for improvement. We learned otherwise after testing the new tapered plug cutter from Veritas Tools.

Although plug cutters are best used on a drill press, this one performed nicely even when chucked into a ⅜-in. electric drill supported on a drill guide (far right). The inside of the plug cutter has been reamed so it produces a slightly cone-shaped plug. We found that such plugs wedge into place with hardly a sign of a glue joint (near right). The tapered plug is on the left, the standard plug on the right.

The cutter's taper also helps produce a neat plug by shearing the wood fibers as it is plunged ahead. The result is a nice, smooth plug that practically glides into a screwhole.

Another nice advantage of a tapered plug is that it resists turning as it is pushed into the hole, facilitating grain alignment between the plug and its surroundings.

High-carbon steel cutters are available in three sizes: ¼-, ⅜- and ½-in. diameters. A set of three costs about $26 through woodworking catalogs. Write Veritas Tools, Inc., 12 E. River St., Ogdensburg, NY 13669.

—Rosario Capotosto

PM PHOTOS BY ROSARIO CAPOTOSTO

NEW PRODUCTS

EASY DOES IT

Fourteen ways to make summer more enjoyable.

BY ROY BERENDSOHN, Assistant Home Improvement Editor

Thin Skinned

Apply this vinyl solar film to your sun porch windows or anywhere else you want to cut sunlight infiltration and reduce cooling costs. Simply peel off the film in the fall and reuse it again next summer. It clings to the window with static electricity. Its manufacturer says it rejects 55.2% of the solar energy that would enter through the window and 82.3% of the ultraviolet light. The film comes in bronze or gray, and costs about $1.10 per sq. ft. A 36-in.-wide × 15-ft.-long roll is enough to cover a pair of 6-ft.-wide patio doors. It costs $50 at home centers and lumberyards, or from Solar Stat, Inc., 500 190th St. N.E., Miami, FL 33179; (800) 783-0454.

Light Up

The Reflex combines a dual-bulb 500-watt floodlight with a motion sensor in one preassembled unit. It installs by wiring into a junction box and can detect motion 70 ft. away. The unit's built-in swivel plate allows you to take full advantage of the unit's capability, wherever it is mounted. An integral photocell turns off the floodlight at daybreak. It costs about $40 at hardware stores and home centers. Write Heath Zenith Reflex Brand Group, Hilltop Rd., St. Joseph, MI 49085.

No-Stick Grilling

The Griffo Mark Series grills are made of porcelainized steel so food won't stick to them, and they are easy to clean. The grills' openings are large enough to allow rapid cooking, but too small to let shrimp, scallops and other fine—but small—foods fall through. They come in five sizes and shapes for gas and charcoal grills, kettle grills, smokers and even one to fit Jennair downdraft grills. They cost from about $16 to $40. They are sold at hardware stores and supermarkets. For more information on the Mark series and other barbecue products, write to Griffo Products, Inc., 301 Oak St., Quincy, IL 62301.

High-Powered Grill

Jennair says it has introduced the first major appliance electric grill to receive a UL-listing for outdoor use. Both the 18-in.-wide single grill and the 30-in.-wide double grill (shown) are powered by 2800-watt grill elements requiring 240 volts. Although its grills are permanently installed, they are hinged so they can be pivoted up to allow the porcelainized-steel grill basin to be cleaned. Both grills are downdraft ventilated so smoke can be removed from the cooking area. The 18-in. model costs about $575, and the 30-in. model costs $700 at Jennair dealers. For more information, write Jennair Co., 3035 Shadeland, Indianapolis, IN 46226-0901.

Get Reel

Designed to eliminate tangles, the HoseKing features a sliding guide to uniformly wind and unwind garden hose. It accepts 325 ft. of ½-in.-dia. hose or 225 ft. of ⅝-in.-dia. hose. It's made of polypropylene, so it won't rust, and all of its components snap or screw together. Its features include a tool storage tray and a 5½-ft.-long leader hose, with a quick-release connector, to hook up to an outdoor faucet. The HoseKing comes with a limited lifetime warranty and costs about $75 at home centers and hardware stores. Write Ames Lawn and Garden Tools, P.O. Box 1774, Parkersburg, WV 26102.

$2009.75 incl. pg. 76

Plan Your Plot

This kit addresses one much-overlooked aspect of vegetable growing, namely planning—from the beginning of the season to the harvest. The Gardener's Guide helps you plan the location of your vegetable garden and the management of it. Each kit contains a ½-in.-scale layout grid, reusable vinyl plant symbols and a weekly schedule to organize garden activity. General planting information is also included, such as sunlight, water and nutrient needs of 50 popular vegetables and companion plantings, space requirements and a nationwide frost schedule. The guide costs about $24 from Gardener's Guide, 6510 Page Blvd., St. Louis, MO 63133.

Long Reach

You can remove and reinstall floodlight bulbs without standing on a ladder, using the Smart Bulb Changer. The suction cup device screws onto an extension pole that has ¾-in. Acme threads. A release clip allows you to remove bulbs quickly and easily. The bulb changer costs about $11 (pole extra) at hardware stores and home centers. Write Mr. Longarm, Inc., 400 Walnut St., Greenwood, MO 64034.

Skeeter Beater

This insect repellent is formulated to protect you against nearly all the potentially harmful insects you're likely to encounter. It repels mosquitoes, ticks, flies, fleas and gnats. Its manufacturer claims it repels mosquitoes for 4 hours and biting flies for 8 hours. It's gentle enough to use directly on your skin, its manufacturer says. It's sold in 2- and 4-ounce spray pumps and a 2-ounce pocket-size lotion ($3.50 to $4) at sporting goods stores and pharmacies. Contact Sawyer Products, P.O. Box 188, Safety Harbor, FL 34695.

Grill Thrill

Replace the lava rocks in your gas grill with the Lazz-E-Grill Smoke-N-Flavor system and barbecue foods 50% faster than before, cook more evenly, save fuel and eliminate flare-ups, says its manufacturer. It consists of two steel plates and a support that lay on top of the grill that would normally hold the lava rocks. It takes just minutes to install. Juices drip on the plates and are turned to smoke. Also known as the BBQ-Flame Master, it costs about $30 at hardware stores and Suburban Propane outlets. Contact Janco Products, Inc., 110 B Valley Oaks Dr., Visalia, CA 93291.

PM ILLUSTRATION BY RON CARBONI

In The Swim

A homeowner can build this log swimming pool in three days, says its manufacturer. Each pool is constructed of Aspenite panels, foam sheeting, heavy-gauge vinyl liner and 8-in.-dia. southern yellow pine logs that are spiked together. The company says it uses computer-controlled cutting to ensure that the logs fit precisely. It can be installed completely inground, out of ground or in between. A variety of shapes and sizes are available ranging in price from $7700 to $18,200 at Lincoln Log Home dealers (the 26-ft.-wide octagon pool, shown, costs about $8200). For more information, write Lincoln Log Home Pools, 6000 Lumber Ln., Kannapolis, NC 28081.

Night Lights

Add a little color to the nighttime landscape with these amber, blue, green and red sleeves for low-voltage outdoor lights. Truly a do-it-yourself installation, the silicone sleeves slide over any 12-volt wedge bulb that's 11 watts or less. A set of four costs about $10 at hardware stores and home centers. For information, write Intermatic, Inc., Intermatic Plaza, Spring Grove, IL 60081-9698.

Plan Ahead

Look no further for plans to build outdoor furniture, decks, planters and other structures. The Western Wood Products Association has made a variety of plans available at minimal cost. The latest entries (75 cents each) are plans No. 26—a round patio table with benches, and No. 29—three planters. Both plans contain step-by-step instructions, a materials list, plentiful dimensions and exploded views. The *Outdoor Space* book provides an overview of WWPA plans for decks, trellises and structures designed for different styles of houses. It costs about $2. To order the booklets, or to get more information, write WWPA, Yeon Building, 522 Fifth Ave. S.W., Portland, OR 97204-2122.

Deck Brightener

Dekswood not only rejuvenates your faded deck, but you can also use it to clean plastic or wood outdoor furniture. To use, mix one part Dekswood to four parts water, wet the surface to be cleaned, then apply the cleaning solution, scrubbing lightly with a brush. Allow the solution to stand for 15 minutes, then rinse with a garden hose. It's sold in quart and gallon sizes (about $5 and $16) at hardware and paint stores. Contact the Flood Co., P.O. Box 399, Hudson, OH 44236-0399.

See In The Dark

First Alert's rechargeable flashlight helps you see at night by incorporating advanced features. Its head rotates up and down 45°. Its body is shaped for stability when you lay it on a flat surface, and its beam width is adjustable. These features allow the flashlight to be used like a lantern. To recharge it, unfold its prongs and plug it into an outlet. The flashlight costs about $30 at hardware stores and home centers. Write First Alert, 780 McClure Rd., Aurora, IL 60504-2495. PM

NEW!...THE MOST POWERFUL...MOST ACCURATE CLUB IN GOLF!

The CONTROLLER® HITS 30-50 YARDS LONGER, AUTOMATICALLY CORRECTS HOOKS AND SLICES ...MUST CUT STROKES — OR MONEY BACK!

Put your #3, #4 and #5 woods in the cellar. Tests show our new Controller driving iron can outhit all three by 30 to 50 yards.

And that's only half the story. The Controller automatically corrects hooks and slices! The club is so powerful, so accurate, we unconditionally guarantee it will cut 5 to 10 strokes off your score — or you owe us nothing! In fact, to prove it we'll send you one risk-free.

Test it against your #3 wood. If it doesn't give you 30 more yards (if you are a fairly good golfer), send the club back for a refund.

But it will give you 30 more yards! In fact, the Controller is so powerful many golfers use it off the tee, especially on narrow fairways.

Here is the Controller's exact distance advantage as compiled by some low-80's golfers.

CONTROLLER®	220 yards
#3 Wood	190 yards
#4 Wood	180 yards
#5 Wood	170 yards

Now test the Controller's accuracy against your 3-iron. Purposely hit a shot off the *toe* of each club and watch what happens. Your 3-iron will *hook* the ball violently—the Controller will keep it down the middle! The same is true with *heel* shots. Your 3-iron will *slice* the ball violently—the Controller will automatically keep it on course!

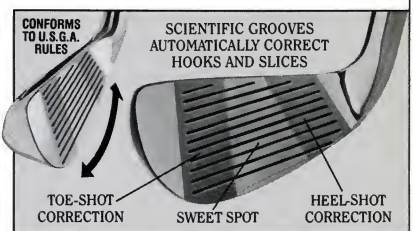
THE GREATEST STROKE-CUTTER IN GOLF

These scientific breakthroughs make the Controller driving iron the most powerful strokecutter in golf. We believe the club will transform the game. First of all, it obsoletes fairway woods! The Controller not only hits 30 to 50 yards farther than fairway woods, it automatically corrects hooks and slices! Here's how it works.

AUTOMATIC ACCURACY

The Controller has an *invisible curve* across its hitting surface—a curve that's going to revolutionize your game. *No other iron has it!* Hit a shot off the Controller's sweet spot and it will go straight, as it would with an ordinary iron. But even pros hit off the heel and toe.

Now, here is the Controller's genius...here is why you could cut as many as 10 strokes off your score. Hit the ball off the Controller's heel or toe and its invisible curve will automatically impart a corrective spin to what would otherwise be a disastrous hook or slice. The ball will actually fade or draw back on course! It's an incredible sight and you can prove it to yourself with only a few test shots. THIS IS THE MOST IMPORTANT GOLFING BREAKTHROUGH IN GENERATIONS. ALONG WITH THE CONTROLLER'S EXTRA 30-50 YARDS, YOU SHOULD EASILY CUT 5-10 STROKES OFF YOUR GAME!



Here are more reasons why the Controller driving iron is going to give you the best golf of your life...

- it gives you the power of a driver with the control of an iron...
- its sleek, smooth head swoops through grass more cleanly than a wood...
- its 17° loft gets your shot up faster than a #3 wood...
- its smaller head size (versus a wood) boosts clubhead speed...
- its boron-graphite shaft model adds even more clubhead speed...
- it lets you carry more wedges and putters without exceeding the 14-club limit (by eliminating your #3, #4 and #5 wood)...

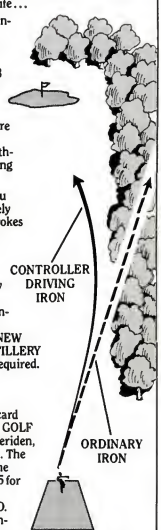
The Controller is new and supply is limited. You must act now and remember, you are completely protected. If the Controller doesn't cut 5-10 strokes off your score, you may return it (undamaged, of course) for a prompt refund of its price.

FREE!

...just for trying the Controller! Keep your new power pin-high with a $15.00 Rangefinder! It's yours to keep FREE! even if you return the Controller for a refund. NOW YOU CAN RANGE YOUR NEW DISTANCE LIKE AN ARTILLERY OFFICER. No batteries required. Clips to belt.

HOW TO ORDER

Send your name, address and check (or credit card number and expiration date) to the NATIONAL GOLF CENTER (Dept. DR-120), 500 So. Broad St., Meriden, CT 06450. Or call 203-238-2712 (8-8 PM, M-F). The steel-shaft CONTROLLER costs only $59.00; the carbon-graphite model costs $89.00. Add $4.75 for s/h/ins. CT and NY must add sales tax. Specify regular or stiff flex, right or left-handed. No P.O. boxes, all deliveries are UPS. A refund is guaranteed if a club is returned undamaged within 30 days. Clubs are also available in ladies size, steel or graphite, same prices.



THE CONTROLLER HITS LONGER AND STRAIGHTER THAN ANY OTHER CLUB IN GOLF. IF IT DOESN'T CUT 5-10 STROKES, YOU OWE US NOTHING! ACT NOW!

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HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Warm-Air Heat

I am thinking of buying a house that has warm-air heat. Could you tell me some of the advantages and disadvantages of this type of heating system?

DAVID KOCH
CLIFTON, NJ

In a warm-air heating system, the air is heated in a furnace that is usually oil or gas fired, although it can be heated by electric-resistance coils. The heated air travels via supply ducts and enters the room through wall or floor registers or ceiling diffusers. Cooler air is displaced by heated air and travels through return ducts back to the furnace.

There are a number of advantages to this system. The air can easily be filtered and humidified or cooled to provide air conditioning.

Also, if there is an extended power failure during the winter, the heating ducts are not vulnerable to freezing and bursting, as are heating pipes.

A disadvantage of a warm-air, gas-fired or oil-fired system is that, in the rare event of a defective heat exchanger, poisonous carbon monoxide from the exhaust gas can mix with the circulating air and be distributed around the house. This also introduces excessive moisture (from the combustion process), in the form of condensation, into the house.

When the system is off, no heat enters the house, unlike the residual heat that is released from hot-water radiators. Also, a hot-air system has a central air filter that needs to be regularly cleaned or replaced.

Smooth Sliders

I live in a condominium that is 17 years old. The glass and screen doors have become a major problem, and owners are getting conflicting information on how to keep them opening and closing smoothly. The doors lift up and pull out, but most of us are not strong enough to do this. What is the best way to maintain these?

KARL KUNZE
OXNARD, CA

Once the doors are no longer sliding smoothly, get someone to lift them out of their track. Then, clean around the bottom wheels. Over the years, dog hair, dust and dirt accumulate around the wheel bearings, constricting them.

If the doors slide smoothly, the best way to maintain them is to keep clean the channel track that they slide in by periodically brushing them out or vacuuming them with a narrow nozzle. Wipe out any remaining grit with a damp sponge, dry the channels, then lubricate them with powdered graphite or a silicone spray.

Slow Recovery

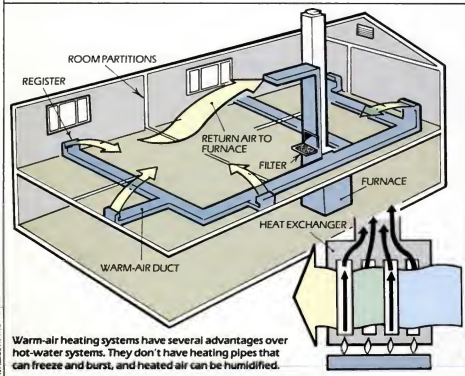
We remodeled our kitchen and replaced our 40-gallon, gas-fired water heater with an electric water heater that has a 5500-watt element. Now we are stuck with a tank that is good only for me and my wife. When our three grandchildren come to visit, the water is not hot enough for them to bathe at half-hour intervals, like they did when I had a gas-fired water heater. Would you please help?

ROLAND LAFLEUR
OPELOUSAS, LA

People switching from a gas-fired to an electric water heater frequently cite the problem you discuss. When selecting a water heater, consider its capacity and the recovery rate. The recovery rate is the number of gallons that the unit will heat to 90° to 100° F above its inlet temperature in 1 hour. When the tank capacity is low, in order to have an adequate supply of hot water, the unit must have a high recovery rate. As an example, a typical oil-fired water heater has a 30-gallon capacity and a 120-gallon-per-hour recovery rate.

Electric water heaters, on the other hand, have a low recovery rate: usually about 18 gallons per hour, although some units have a 22-gallon recovery rate. With such a low recovery rate, unless there is a large tank capacity (on the order of 60 to 80 gallons), a simultaneous long-time demand for hot water will result in an inadequate amount of hot water being supplied to the fixture.

You can increase your heater's hot-water output by installing a prewarming tank in series with the water heater. The cold-water supply is connected to the prewarming tank's inlet, and the tank's outlet is connected to the water heater's inlet. By boosting the temperature of the water entering the water heater, you improve its recovery rate. It is also more economical because you are not electrically heating a large volume of water all day, so there will be sufficient supply during the peak periods. **PM**



Warm-air heating systems have several advantages over hot-water systems. They don't have heating pipes that can freeze and burst, and heated air can be humidified.

PM ILLUSTRATION BY ED LIPINSKI

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, $5.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Car owners!

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Stay in tune with your car!

You've seen the price of new cars...they go up every year! Cars get flimsier...prices get higher...it never seems to end. There are lots of reasons to keep that nice car of yours on the road as long as possible.

Car sales are down and Tufoil sales are up. People are smart...they're taking the economical way out and what could be easier than Tufoil. Just add Tufoil to the crankcase. You don't have to shake the container or add an engine flush. Just pour it in and drive away.

Your throttle will get silky smooth...acceleration will improve. One customer said his car "takes off like a scared rabbit!"

Tufoil works wonders for all known engine oils. It's actually slipperier than Teflon (according to a famous U.S. Government laboratory).

You'll get astonishingly fast starts on cold mornings with both diesels and gas engines. The Canadian government tested Tufoil at it's cold regions lab. They showed faster cranking and significant fuel savings with Tufoil.

What about additives that claim to be a one-time treatment that will last the life of an engine? Well, I've been following the scientific literature on lubrication for a very long time. As far as I know, there isn't a shred of scientific evidence for such a claim. So don't believe it!

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Engines last longer with Tufoil. Our 1976 476 T-Bird is now at 190,000 miles and purring.

A bunch of customers' cars have now passed 250,000 miles.

Several months ago, a nice man I'd never seen before walked into my office, big smile on his face, sat down and said, "Would you believe 340,000 miles on a Tufoil engine?" He went on to rave about how well his engine has been running all these years. I couldn't get a word in edgewise.

Recently, a truck driver called in with over 1,000,000 miles on a diesel using Tufoil - WOW!

A customer from Vermont added 10% Tufoil to his sticky mechanical transmission, called in and said he couldn't believe it..."Shifting is like slicing butter now!" he said.

SAAB owners are writing letters praising Tufoil in their "NINES" magazine. They report spectacular improvements in their engines and transmissions!

Don't forget! **Tufoil is the result of over 15 years of research and development. The U.S. government has awarded us 6 patents so far...so have Germany, England, France and Canada.**

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MAINTENANCE BASICS

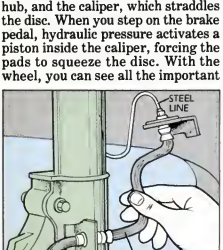
INSPECTING DISC BRAKES

BY DON CHAIKIN

● Today, disc brakes slow and stop the front wheels of every new car, pickup truck and sport/utility vehicle sold in America. On many cars, you'll find discs on the rear wheels as well.

Disc brakes do a better job than drum brakes, and they're also easier to inspect and maintain.

The system consists of the disc, or rotor, which is bolted to the wheel hub, and the caliper, which straddles the disc. When you step on the brake pedal, hydraulic pressure activates a piston inside the caliper, forcing the pads to squeeze the disc. With the wheel, you can see all the important



Check hoses for flexibility and damage from chafing. Inspect connections for leakage.

pieces without any disassembly.

Here's the step-by-step procedure:

● Chock the rear wheels. Jack up the front of the car, and support it on safety stands. Remove the front wheels.

● Check the rotor. It should be smooth and shiny where the pads make contact. Look for nicks, cracks, deep wear lines or scoring. Turn the steering wheel all the way left or right to inspect the rotor's inner surface. You can also use a mirror.

Fine grooves in the disc, like the grooves on a record, are acceptable—if they're not deep. Drag your fingernail across the surface of the disc, from outer edge to inner and back again. Any groove or ridge that snags your nail indicates a problem.

● If your car has vented rotors—deep spaces between the inner and outer edges for better cooling—remove any debris from the vents.

● Check for pad wear. Most calipers have an inspection hole so you can see the outer edges of both pads. Gauge pad thickness by looking at the leading and trailing edges.

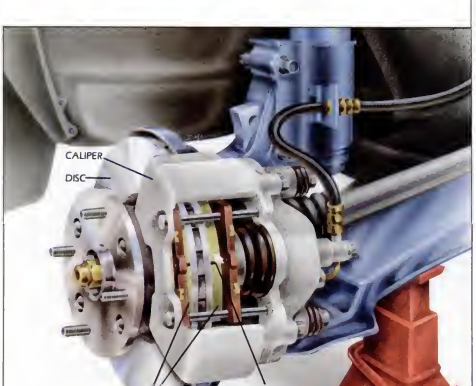
Many pads have a built-in wear indicator—a deep groove down the middle of the lining. When the groove is gone, the pad should be replaced. Others have a metal tab embedded in the pad to provide an audible warning that the pad is due for replacement.

● The pads of each brake should wear evenly. Uneven wear means the caliper or piston may be sticking.

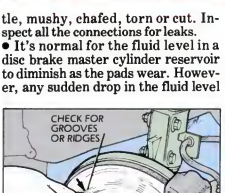
● Thoroughly inspect the brake hoses and connections to the caliper. Flex the hoses to be sure they're not brittle, mushy, chafed, torn or cut. Inspect all the connections for leaks.

● It's normal for the fluid level in a disc brake master cylinder reservoir to diminish as the pads wear. However, any sudden drop in the fluid level probably does indicate a leak.

● Make sure that all mounting bolts are snug and that the pads' retaining clips and pins are secure and not bent or caked with mud or rust. PM



Most brake pads have built-in wear-indicator grooves. When groove disappears, it's time to replace the pad.



Drag thumbnail across the rotor surface. If it snags, the rotor may need resurfacing.

PM ILLUSTRATIONS BY DON MANNES

HOW IT WORKS

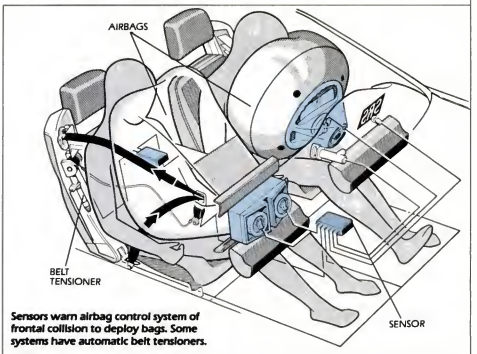
AIRBAGS

BY DON CHAIKIN

● Despite all the advertising hype surrounding airbags, your best protection against injury in a collision is still your seatbelt. However, since too many of us refuse to buckle up, the federal government has mandated automatic, or passive, restraint systems for all cars.

While some manufacturers have responded to this mandate with automatic front shoulder belts, most are turning to systems using 3-point belts supplemented by an airbag.

For now, most airbag-equipped cars protect only the driver, and trucks are still exempt from mandatory passive restraints. However, most carmakers are looking ahead to future regulations, and future models will have an airbag to protect the front-seat passenger, too.



Sensors warn airbag control system of frontal collision to deploy bags. Some systems have automatic belt tensioners.

Collision physics

To appreciate the potential benefit of airbags, it's helpful to understand the physics of an accident.

When a car runs into something immovable—a bridge abutment, for example—it stops pretty much instantaneously. Everyone inside the car, however, keeps going until something stops them. For unbelted drivers, that something is usually the steering wheel. For unbelted front-seat passengers, it's the windshield.

All moving objects possess kinetic energy. The greater the velocity and the greater the mass of the object, the greater the energy involved. When the object stops, that energy has to be dissipated, either by transferring to another object or conversion into a different type of energy. A car's kinetic energy is absorbed by the bumper, hood, fenders and chassis as they crumple. For the unbelted driver, the collapsing steering column absorbs some of the energy. The part of you that hits the wheel absorbs the rest.

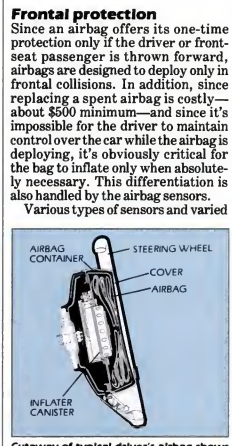
Seatbelts absorb energy by stretching. They also spread the remaining energy over a wide area. However, if the car is moving fast enough and hits something truly immovable, there may be more energy than the seatbelt can absorb. Your next line of defense is the airbag.

At the instant the car begins the kind of slowdown that goes with a collision, the airbag's sensors detect the massive deceleration. If the rate of deceleration exceeds the sensors' thresholds, current flows to an igniter stored at the airbag to inflate the bag. The entire process—from sensing to full deployment—takes only 10 to 50 *thousandths* of a second.

Frontal protection

Since an airbag offers its one-time protection only if the driver or front-seat passenger is thrown forward, airbags are designed to deploy only in frontal collisions. In addition, since replacing a spent airbag is costly—about $500 minimum—and since it's impossible for the driver to maintain control over the car while the airbag is deploying, it's obviously critical for the bag to inflate only when absolutely necessary. This differentiation is also handled by the airbag sensors.

Various types of sensors and varied mounting points are used. Some are spring-loaded weighted rotary switches, others are pendulum or cantilever switches, and still others are mercury switches.



Cutaway of typical driver's airbag shows position of components.

Whatever the switching system may be, a specific force is needed to overcome the tension in the switch, and that force has to come from the correct direction. Generally speaking, this force is equivalent to a frontal collision with a stationary barrier at anywhere from 15 to 30 mph, depending on the system.

When the sensor switch closes, it completes a circuit with the control unit, which determines whether a frontal collision is really in progress (as distinct from a system malfunction). Typically, the control unit relies on signals from two different sensors.

Since the car's battery and alternator are often among the first casualties of a head-on collision, the control unit has its own power reserve to trigger it. The control unit completes the circuit to the airbag igniter, which heats rapidly, initiating a chemical reaction in the sodium azide propellant. The reaction generates a harmless gas, mostly nitrogen, at near-explosive rates, inflating the airbag. Screens inside the igniter assembly cool the gas as it fills the bag.

The airbag itself is a thin nylon sack covered with cornstarch, which acts as a lubricant to help the bag unfold without snagging. As the bag inflates, it breaks open its container. Once inflated, it begins to deflate through vents, cushioning the driver. PM

SATURDAY MECHANIC

REPLACING FILTERS

BY PAUL WEISSLER

● Although today's cars are protected by more self-diagnostics and fail-safe systems than ever before, the first line of defense dates back to the origin of the species.

They're hardly high-tech, but filters stand guard in most of your car's systems, trapping oil contaminants, turning back dirt in the fuel system and shutting the door on airborne abrasives trying to make their way into the induction system.

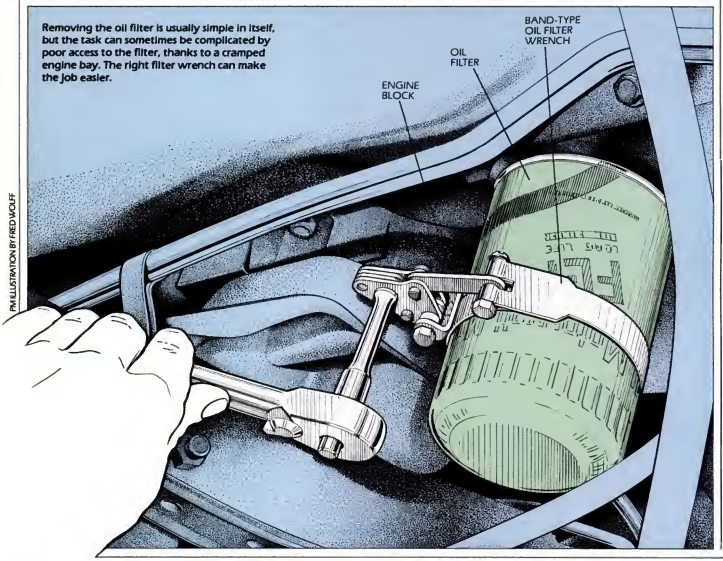
Considering their importance, and how easily they can be maintained or replaced, it's worthwhile to make a regular filter patrol part of your car care routine. In terms of making your car run better longer, the time it takes pays higher dividends than any other routine maintenance chore you can tackle.

Oil filters

Locating the oil filter remains easy on almost all cars. It's threaded onto the exterior of the engine, and you'll just have to look (sometimes hard). The only noteworthy exception: On some late-model General Motors' cars with 2.5-liter 4-cylinder engines, it's in the oil pan (loosen a giant plug to drain the oil, then remove the plug and pull out the filter with pliers).

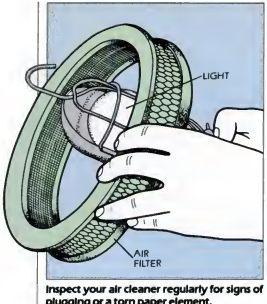
To be able to remove the filter, you'll need to raise the car, either with drive-on ramps or a hydraulic jack to lift the car by a crossmember, followed by safety stands under the suspension arms.

Carmakers' recommended filter replacement intervals vary, but you can't go wrong changing the filter whenever you change the oil—at least twice a year, every three to four months or 3000 miles if you do a lot of short-trip, heavy-load or stop-and-go driving. Removing the old oil filter should be a straightforward operation



Removing the oil filter is usually simple in itself, but the task can sometimes be complicated by poor access to the filter, thanks to a cramped engine bay. The right filter wrench can make the job easier.

PM ILLUSTRATION BY FRED WOLFF



Inspect your air cleaner regularly for signs of plugging or a torn paper element.

if you have a filter wrench that fits in and on. The old strap wrenches are "universal," in that they grasp the filter body and will work on any filter within a broad size range.

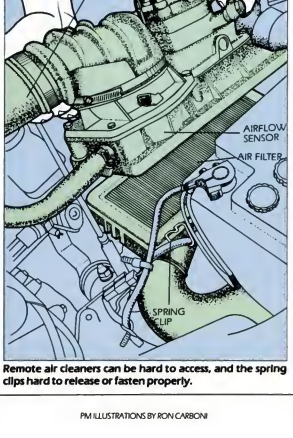
If a strap wrench won't fit in, you may need an end-cap wrench, which usually fits into even the tighter quarters on some cars. The end-cap wrench locks against flutes on the end of the filter. Even if you have a wrench that's the right diameter for your car's filter, you must also make sure the flute pattern of wrench and filter also match. If you installed the old filter with that wrench, there's apparently a match. However, if you buy a different brand replacement filter this time, bring along your wrench to make sure it will work.

If you don't have a wrench, and need an end-cap, check the wrench you buy against a filter of the same brand that's on your car. Then get a replacement filter with the same flute pattern (it need not be the same brand). Or buy a universal end-cap wrench with spring-loaded "fingers" that lock against several flutes, enough to loosen the typical filter within its specified range.

Some filter designs will last a bit longer or remove slightly finer dirt particles, but if you use any name-brand or major store brand and change the filter at reasonable intervals, you should never encounter an oil filtration problem. Always buy a filter recommended in the maker's current catalog for your car's engine, model and year. Just because a different number looks the same doesn't mean it is, and it may give you problems with installation, or eventually work loose and leak, even if it doesn't leak immediately.

If the wrench is a strap-type, position it on the filter as close to the base as possible. Place a drain pan under the filter, and if the filter is recessed, make a trough of aluminum foil so when you loosen the filter any oil flows along the trough into the drain pan rather than on the ground, or, even worse, onto a wiring harness, before dripping onto the ground. Or you can wrap the harness with foil to protect it.

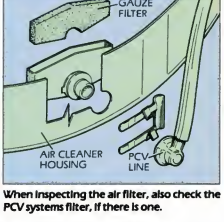
Having a problem trying to loosen a badly stuck filter? If the filter simply distorts without loosening when you use an end-cap wrench, you've got to put a wrench around the filter right at the base, even if there isn't much room to turn a handle. You may be able to do it with chain-type locking pliers, a plumber's strap wrench or an oil filter strap wrench, but for a real problem the best choice is a pair of oil filter removal pliers, such as the Vim V-240 and V-241 (Durston Manufacturing Co., LaVerne, CA 91750). Our favorite universal tool is actually the 24-in. Channelock pliers, which costs about 40 bucks but has plenty of other uses around the shop.



Remote air cleaners can be hard to access, and the spring clips hard to release or fasten properly.

Once you have the old filter off, check to make sure the rubber gasket came off with it. If it didn't, reach up and dig it out. If you don't, you'll have an oil leak, as the two gaskets will distort when squeezed together. Clean the filter mounting surface with a cloth.

Apply a thin film of clean oil to the new filter's gasket, then thread on the



When inspecting the air filter, also check the PCV systems filter, if there is one.

filter. It should thread on smoothly. If you encounter resistance, stop, as you may be cross-threading. Be careful not to scrape the filter over anything as you're worming your way through the engine compartment up to the filter mounting pad—you don't want to collect any dirt and inject it directly into your engine. If the filter is more or less vertical, prefill it with clean oil, to reduce the interval between engine start and establishing oil pressure.

Once you have the filter threaded on, run it down until you feel it just make contact with the mounting surface. Install the wrench (flip over a strap wrench so the band closes when the wrench is turned in the clockwise direction). Then make note of some emblem on the filter body for reference and tighten the filter about a ¾-turn more. You might be able to do this by hand, so avoid distorting the filter with tools if you can.

Replace the drain plug, replacing the gasket washer if necessary. After adding oil, start the engine and check for leaks near the base of the filter.

A word about oil filter interchangeability: don't. Just because a filter seems to screw onto the oil filter flange and has sufficient mechanical clearance doesn't mean it's safe to use it.

There are a number of similar

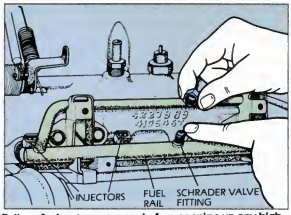
PM ILLUSTRATIONS BY RON CARBONI

filters with slightly different thread pitch and gasket diameters—different enough to pass cursory examination, but fail under pressure by blowing off the threads some cold morning or popping a gasket on a hot day.

Some filters have an internal pressure relief valve, intended to bypass oil flow if the filter medium becomes totally plugged by sludge. The theory is that some dirty oil is better than no oil at all, or having the paper filter burst under the strain and dumping a quart of sludge straight into the engine. Some filters have no such valve, as they're intended for engines that have an internal relief valve.

There may indeed be some substitution possible—and the filter manufacturer's interchange table should be your guide. For instance, there's a larger Ford filter, intended for trucks, that is a direct replacement for the standard PH-8 Ford spin-on.

Another option is a remote filter adapter, with lines running up to a filter mounted on the fenderwell or firewall. The easy access makes a filter change a standup job, and if you mount the filter so it's upright, it's a clean job as well.



Relieve fuel system pressure before opening up any high-pressure fuel filter fittings. Keep a fire extinguisher handy.

Air filters

The air filter always used to be atop the carburetor or throttle body, under an easily accessible cover held by a wingnut. Every couple of years, you simply took off the wingnut, lifted the cover, removed the old element, cleaned out the housing and installed the new one.

If you live where there isn't any dust or airborne dirt to speak of, check the filter annually. Dusty conditions shorten the interval considerably, and if you drive on unpaved roads, every three months is more like it.

Lower hoodlines mean filter housings located away from the carburetor or throttle body. If you aren't sure where, trace the large, flexible air duct from the top of the engine until you come to a large metal or plastic housing with a cover, and it's probably there.

In many cases, the filter cover is held by spring clips, and you may have to work in with a screwdriver to release and reengage the clips. Some filter covers also hold a section of the fuel-injection system, so you may have to unplug a wiring connector for working clearance. If you do, inspect its retainer carefully so you don't break a plastic tang taking it off. When you refit a connector, be careful not to bend any terminals.

Inspect the filter, and if there's only one dirty spot, opposite the intake air snorkel, just tap the filter against a workbench to remove loose dirt, then turn the element and reinstall. Of course, if you live in an area where there's a lot of airborne sand, it may not darken the element. In that case, hold a shop light up to the inboard side of the element. If the filter is clear, you should see uniform lines of light shine through at the pleats.

Here again, get the *exact* filter element specified for your car. If a filter is just slightly smaller, it won't fit the housing properly and unfiltered air can leak into the engine between the element and the housing.

When you're changing the filter, also look in the housing for a small gauze filter used on older carbureted engines to clean the intake air for the Positive Crankcase Ventilation (PCV) system. If this gauze filter is dirty, pull it out and install a new one.

At the same time, check the ductwork connected to the air filter housing. Of course, it should be connected at both ends, but it also should be free of any tears. A torn or loose hot-air duct for a thermostatic air cleaner can allow cold air to leak in and affect driveability until the engine is warm. A torn or loose duct from the air cleaner to the carburetor or throttle body allows unfiltered air to get in. On cars with airflow sensors, leaks permit unmeasured airflow, which can result in a lean fuel mixture, leaving you with a driveability problem you'll have a hard time tracing.

Gasoline filters

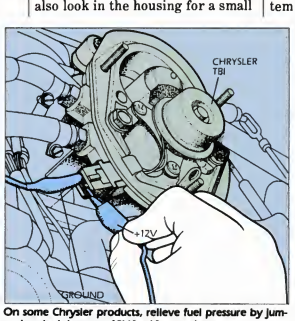
The gas filter is usually under the hood, and if you trace the fuel line from the carburetor or fuel injectors, you'll come to it. Not under the hood? Well, maybe it's underneath, such as just forward of the gas tank on some models. In these cases, you'll have to lift up the rear of the car for access.

Many carmakers don't recommend specific fuel filter replacement intervals. However, even without apparent driveability symptoms, it's a good idea to change the fuel filter every two years.

There are some close brushes with high technology on cars with fuel injection, because you must relieve system pressure of anywhere from 15 to 60 psi (depending on the type of system) before you can change the filter. This is unlike carburetor systems, which operate on modest pressures in the 3- to 6-psi range, with little or no residual pressure. However, dealing with the higher pressures of fuel-injection systems needn't frighten you.

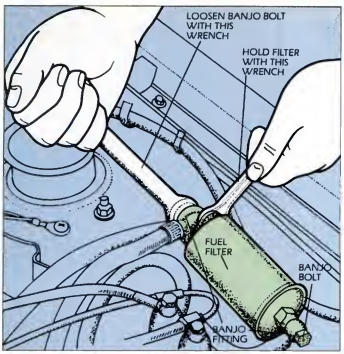
If your fuel system has a tire-type service valve, called a Schrader valve, installed to simplify connection of a pressure gauge, just remove the cap, wrap a towel around the valve to collect fuel spray and depress the pin. Safety glasses, please. When the fuel stops spraying out, the pressure is relieved.

A similar setup is used on fuel-injected Hondas—a threaded plug that can be removed to in-

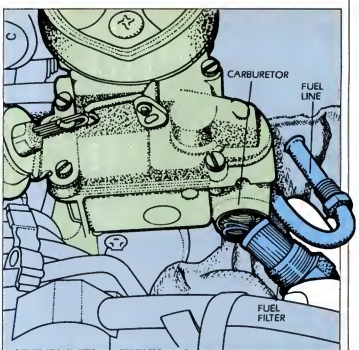


On some Chrysler products, relieve fuel pressure by jumpering the injector to 12V for 10 seconds or so.

PM ILLUSTRATIONS BY RON CARBONI



Now you can remove the fuel filter itself by carefully unscrewing the appropriate fittings and clamps that hold it in place.



Some carburetors are equipped with a small filter where the fuel line enters the carburetor body.

stall a pressure gauge. The plug is on the fuel rail (tubing) next to the pressure regulator, and all you have to do is hold a fitting with one wrench while you loosen the plug with a second wrench. Wrap the fitting with a towel to collect seeping fuel, of course.

You may be able to remove a fuel pump fuse, followed by cranking the engine for 10 seconds. With the pump disabled, the pressure will be dissipated. This may set a trouble code in your engine computer, but don't worry, because it shouldn't cause the CHECK ENGINE light to repeatedly come on. You could disconnect the car battery for about a half-minute to erase the code—not a bad idea for general safety if you're disconnecting fuel lines or operating a Schrader valve under the hood. However, most engine computers have sophisticated programs that include adaptive learning. It means the computer has adjusted the engine controls for your driving style. Disconnecting the battery erases this data, and it will take perhaps 100 miles of driving for the computer to relearn.

There are other methods to relieve system pressure. On Chrysler throttle-body injection systems, there is no Schrader valve, so unplug the injector's wiring connector and hot-wire the injector with jumper wires—one to battery positive, one to ground—for just a few seconds, and you'll open the injector long enough.

Or, check a wiring manual for the fuel pump ground location. You can also get underneath the back of the car and trace the fuel pump wiring to the ground connection (typically a black wire), and disconnect it. Disconnecting the ground may be one of the least convenient ways to stop the pump to relieve system pressure by cranking, but you can use the technique on just about any car.

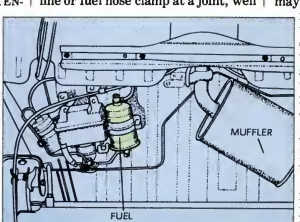
Finally, here's another universal method. Very gradually loosen a fuel line or fuel hose clamp at a joint, well wrapped in a towel, and let the fuel seep out. This is what we do, but we're careful, and we keep a fire extinguisher nearby.

The exact procedure for taking out the old filter varies, but it should be obvious. Standard fittings that thread together are the most widely used on both carbureted and fuel-injected cars. Just hold one fitting while you loosen the other (which one to hold should be obvious). Many fuel-injected engines have banjo fuel filter fittings that get their name from their shape. A bolt goes through the banjo with gaskets on top and bottom. These gaskets should be replaced when you change the filter.

If the filter is clamped to hoses, you may be able to loosen the clamp and reuse it, but do this only if it's a worm-drive type. With all others, including the spring-wire type, discard the clamp and install new ones. In fact, the only way you can get some clamps off is to chop them apart with side-cutter pliers.

On most carbureted GM cars, the filter is in a carburetor boss. Disconnect the line, then remove the fuel line fitting for access.

A cheap, ineffective fuel filter may allow dirt to damage some pretty expensive components, so don't gamble. A quality aftermarket brand should be considerably cheaper than original equipment, because you can buy it from a parts store (with a generous discount structure) instead of a car dealer. However, if there is no reputable aftermarket replacement, spend the extra money for an original equipment replacement. PM



Can't find the filter in the engine compartment? It may be under the car, just ahead of the fuel tank.

PM ILLUSTRATIONS BY RON CARBONI

How to separate the men from the boys.

GM

*See your Chevrolet dealer for terms of this limited warranty. A deductible will apply after 12 months or 12,000 miles. ‡EPA est. MPG city 17, highway 27. † 1990 GM Corp. All Rights Reserved.
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The new Lumina Z34 ▪ Distinctive aero bodywork. ▪ New Twin Dual Cam V6 power. ▪ Slick-shifting 5-speed gearbox. ▪ Aggressive sport suspension. ▪ 4-wheel disc brakes. ▪ P225/60R-16 Goodyear Eagle GT+4's. ▪ 3-year/50,000-mile Bumper to Bumper Plus Warranty.*
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Power *and* efficiency? Meet the future of high performance: The Chevy Lumina Z34. Flaunting 3.4 liters of fuel-injected, 24-valve Twin Dual Cam V6 power, this is the machine for 1991. Because of its advanced multi-valve technology, the Z34's TDC V6 combines power with excellent efficiency.† And with bodywork influenced by our NASCAR-winning Luminas, a responsive sport suspension package and a Getrag-licensed 5-speed gearbox, the Lumina Z34 is one serious machine. But don't take our word for it. Grab hold of one. Your driving future never looked brighter.

CAR CLINIC

BY MIKE ALLEN,
Assistant Automotive Editor

The High Cost Of Cheap Inflation

● *This first item was relayed to us by Wade Hoyt, Editor-In-Chief at* Motor, *a companion Hearst publication intended for the service trade. It originated at another trade magazine, the* Atlas Tire Bulletin.

It concerns a technician who was trying to patch a tire after removing a nail with a pair of pliers. Unbeknownst to the technician, the driver had used an inexpensive tire inflator can earlier in the day.

The technician was inserting a rasp into the tire to provide clearance for a rubber plug, common practice for fixing a small hole without removing the tire from the rim. There was a large noise, and the technician woke up in a medivac helicopter with broken bones and a collapsed lung.

If you read the fine print on the cans, you'll learn that some of them use a mixture of propane and isobutane for inflating the tire. Apparently, the technician's hardened metal rasp struck a spark with the steel belt in the tire, igniting this highly flammable mixture.

True, there's a warning sticker on the can for you to peel off and stick onto the tire to warn others of what's inside. But how many of us are likely to do that, especially at night, in traffic or on a rainy day?

Many other quickie flat-fixers use ozone-eating CFCs instead of flammables. It's not practical to use simple compressed air or nitrogen because the pressures required would make the can weigh too much.

Aside from their potential for explosion, many of these devices propel material into the tire to plug up the hole. These substances work just well enough to make it easy to forget there was a problem. However, like cold remedies, this temporary cure deals more with the symptoms, rather than the malady. A leak usually indicates damage. Accordingly, any leak should have the prompt attention of a competent tire technician who can assess the problem and fix it properly, to prevent more damage.

The most responsible method of temporary inflation is a small, portable 12-volt compressor that you can plug into your cigarette lighter.

But if you do use a temporary inflation device charged with flammables, be sure to warn the technician who has the job of making a proper repair. He should remove the tire's valve stem and let it deflate—outdoors—before attempting any work.

PM ILLUSTRATION BY DON MANNES

Cranky

I own a Dodge pickup that has a hard-starting problem—sometimes. What happens is it will crank for a long time and not start. But if I release the key, back to the run position as if it had started, then it will start.

MICHAEL GMERSON
ALGONA, WA

There are actually two circuits that provide current to the coil—one through a ballast resistor to prevent the coil from overheating while the engine is running, and a second that gives a straight shot of 12 volts for extra poop during cranking.

This second circuit is often from the starter solenoid. The second circuit on your truck is kaput, so the truck often won't start while cranking and the voltage to the coil is low. But when you release the key, voltage goes back up to normal. And if a cylinder happens to fire before the engine spins down too far, ignition.

I'll refer you to the schematic. Look for a wire from the solenoid to the coil. Check for 12 volts during cranking, and you'll probably find a loose wire or a bad solenoid.

Dolly's Dilemma

I want to tow a 1982 Oldsmobile Cutlass Supreme with a 3.8 and automatic transmission. I can't really afford a towing dolly right now, so I want to know if I can do this with a towbar.

If so, what's the proper towbar? Can I install a set of brackets on the bumper to make attaching the towbar simpler? And do I really have to remove the driveshaft for trips longer than 25 miles?

MARK HELT
BELTSVILLE, MD

First off, any vehicle with an automatic transmission is a poor candidate for much towing. The transmis-

sion relies on the rotation of the engine for proper cooling and lubrication, so towing for any distance at speeds over 25 mph will destroy the tranny. For an occasional tow—say from the freeway to the garage after some mishap—you can get away with it. This prohibition doesn't apply to manual transmission cars. Just leave the shifter in Neutral.

One exception would be a 4x4 with part-time 4wd—there's a Neutral position in the transfer case. Another workaround for an occasional tow at highway speeds is to leave the towed car's engine running at idle to provide lubrication and cooling. Just be sure it doesn't stall. Or, you can disconnect the driveshaft at the rear axle flange, a simple-but-greasy 10-minute job under the car.

While disconnecting the driveshaft is acceptable for a cross-country jaunt or two, take it from one who knows—it gets old in a hurry, especially in the rain.

Yes, it is possible to attach brackets for a simple pin connection to the towbar—but you'll probably have to

(Please turn to page 92)

Battery Removal Rules

CAR CARE TIP

● Replacing a battery is among the simplest jobs you can do on your own car. It's so simple in fact, that sometimes we forget that it's also potentially dangerous. Start by hosing the battery down with warm water to remove any spilled acid or corrosion. Then remove the negative terminal first.

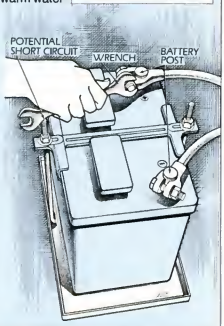
What difference does it make which terminal comes first?

Simple. If you try to remove the positive terminal first, the wrench is electrically "hot," not only in respect to the other battery terminal, but to the rest of the car as well.

This includes the fender, the radiator and the battery hold-down clamps, all of which might be close enough to the positive terminal to contact the other end of your wrench as you're working the cable loose.

And there's enough energy stored in a car battery to weld the wrench into place and turn it cherry red almost instantly.

If you remove the negative terminal first, there can't be any fireworks unless you actually short the two battery posts to each other, which is a lot harder to do accidentally.



PH ILLUSTRATION BY ADOLPHE BROTMAN

$785.00 (AD-PM)

remove the front bumper. It's mounted on shock absorbers, and they aren't designed to be pulled. If you pull off the bumper, it'll probably part with the car at a green light.

I suggest that the cheapest, most effective way to accomplish your mission is to break down and buy the tow dolly. Or, if the mission is occasional, rent one. U-Haul, for example, has a good selection. By putting the drive wheels on the dolly, you sidestep the transmission issue.

There are also a few towing caveats. First, remember that the towed vehicle has no brakes, so braking distances will suffer greatly. And be sure that the towing vehicle is massive enough to deal with the extra weight in back.

Oil Supply

I recently bought a '91 Blazer, and the owner's manual specifies using SG-rated oil. I've been changing my own oil for many years, and I have a supply of SF-rated oil that I'm reluctant to dispose of. Can I use it in my Blazer without harm?

AR BURLEY
FOLSOM, PA

SF-rated oil has completely disappeared from inventories everywhere, but I'll wager there are still a lot of partial cases lingering around in garages and basements. And it does seem like a waste to condemn it to oil cans and lawnmowers.

The major difference between SG- and older SF-rated oil is in the amount of additives intended to prevent sludging during the extended drain intervals for newer cars.

So, if you change your oil at a more normal interval—we recommend 3000 miles—and watch for signs of excess sludge formation, you can safely use this SF-rated oil. (I'm assuming it's the appropriate viscosity for your car.)

However, you should also keep in mind that using an oil with a rating other than the one recommended by your vehicle's manufacturer could very well void your warranty. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

SERVICE TIP

- Ranger, Bronco and Explorer 4x4s built after Aug. 1, 1990, have a different electronic shift module, which requires different procedures to shift in and out of 2wd. Basically, the truck must be stopped and the clutch depressed or the auto trans in Neutral before pressing the LOW RANGE switch. This revised module is also being installed in earlier vehicles if the module is serviced. TSB 90-18-10
- 1989/90 1.6-L Nissan Sentras and Pulsars have revised coolant change procedures. These involve bleeding coolant from a blocked drain plug and an air-relief valve, as well as the radiator drain petcock, flushing the system with water and topping up with coolant. TSB 90-019
- People who are physically unable to fit into 200/700/900-series Volvos because the seatbelt is too short can order a seatbelt extender at the dealer. It will help to extend the seatbelt a few more inches. TSB SM 88-1
- Hyundai Sonatas with 5-speed transmissions may be difficult to downshift into Fourth or into Reverse. If so, replace the restrictor ball assembly, which is supposed to position the reverse-shift lug. If the ball hangs up, difficult shifting will ensue. TSB 015 also suggests changing the lubricant if the ball is sticking.

What's Your Car Worth?

Maybe more than you think. So don't shortchange yourself when you sell or trade it in. Find out your car's true market value instantly by calling the Popular Mechanics CAR VALUE HOTLINE†. Our computer network is constantly updated with the latest information, not only for the year, make, model, options and mileage of your car, but also for your local market conditions and even the time of year.

Buying A New Car?

That's even a better reason to check the PM CAR VALUE HOTLINE†. We'll tell you how to get the best deal by giving you the Manufacturer's Suggested Retail Price, dealer cost, plus the list price and dealer cost of every available option—information you need to get the bargaining edge when negotiating price.

One Call Does It All

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*For used car valuations, call any day 9AM-2AM EST. For new car estimates, call Monday through Friday, 9AM-Midnight EST, Saturday 9AM-7PM. Not available in Alaska or Hawaii. Each call costs $1 for the first minute and $1.95 for each additional minute. Charges will appear on your local phone bill. A typical call lasts 5 to 6 minutes.

$2500.00

NEW PRODUCTS

IMPROVE YOUR CAR

Topless Aural Gratification

Jeeps may be cool with an open top and the wind blowing through your hair. Unfortunately, the wind also blows away the music from your sound system before it gets to your ears. Mopar has a solution to the problem by offering an overhead speaker system for Jeep Wranglers. Called Sound Bar, it's a factory option for 1991 Wranglers, as well as a retrofit for '87 to '90 models. Two Jensen speakers concentrate the music at the front seats. The waterproof speaker system installs neatly into the rollbar. From Jeep/Eagle dealers for $225.

Goodbye Mr. Chips

If you don't want the side of your car riddled with small chips and dings, you can park at the remote end of the lot and walk a few hundred yards. Or, you can slap these foam bumpers on the sides when you park. CHIP Guard has flexible magnets to hold it fast to your car or truck. The magnets are coated so they won't scratch, and the bumpers shouldn't disappear since a strap locks them to your car. The bumpers are available in black or white for $29.95 a pair, nonfolding, or $34.95, folding. From Blister-Pac of Tucson, 4585 E. Speedway Blvd., Tucson, AZ 85712; (602) 327-1775 or (800) 228-9853.

Accordion Lessons

The pickup truck's open cargo bed makes loading easy. It also makes unloading easy—particularly for thieves. A camper top offers security, but reduces convenience. Enter the Cordian Cab. It mounts on rails in the pickup bed so the top can slide out to cover the entire bed or collapse to leave the bed open. It can also be positioned anywhere in between. There's also a movable divider that acts as a lockable tailgate for the partially collapsed cover. This dividing feature makes the cargo bed small enough to corral groceries. Available for Chevy, Ford and Toyota compact pickups, prices range from $1166 to $1440, from Alpha Enterprises, 1340 W. Gladstone St., Azusa, CA 91702; (818) 969-3200.

Pamper Your Seat

Driving home from the beach in a wet bathing suit is even tougher on your car's seat than it is on you. And while driving in wet, muddy or sweaty clothing may be unavoidable from time to time, you can avoid soiling your car's upholstery. The Luxury Liner terry-cloth seat cover has a vinyl backing. It's comfortable to sit on, absorbent and waterproof. The one-size-fits-all cover is machine washable. Priced at $29.95, from Luxury Liner, P.O. Box 813, Highland, CA 92346; (800) 845-4637.

Personal Power Trip

The advent of the mobile office has solved lots of communications problems for moguls on the move, but it's created another: How to provide power for your fax, computer and cellular phone without stopping. An inconvenient solution is a collection of storage batteries.

Or, you can power your equipment from your car's 12-volt system. All you need is a power converter, like the PowerTrip. This unit plugs into your vehicle's cigarette lighter and provides 100 watts of continuous 115-volt AC. That's enough juice to power any equipment that draws 1 amp or less. PowerTrip is pocket-size and weighs less than 1 pound. This power converter is available for $199.99 from Zirco, Inc., 10900 W. 44th Ave., Wheat Ridge, CO 80033; (303) 421-2013. PM

PM PHOTOS BY BILL ASHE

HAMMING IT UP

BY FRANK VIZARD, Electronics Editor

$385.95

● Interest in ham radio as a hobby is on the rebound, thanks to a loosening of governmental regulations. The Federal Communications Commission now offers beginner operator licenses that don't require a mastery of Morse code.

Eliminating the Morse code requirement for the Technician Class license means that people can get on the air without weeks of study. You must still pass a 55-question test governing ham radio operating rules, safety procedures and some basic technical data.

The Technician Class license allows you to communicate on frequencies above 30 megahertz. This license basically confines you to operating only within the United States. Worldwide communication is done on frequencies below 30MHz, and, under international treaty, these operators must know Morse code.

Most people's image of ham radio is of a big, black box with lots of dials primarily used in natural disasters or to hear from the citizens of unstable countries. There are, however, more portable units available. Dash-mounted transceivers for the car are available from companies like Alinco, handheld models are made by companies like Kenwood. While these mobile radios are good for short-range communication, there are about 10,000 repeater stations across the country that extend their range. These repeater stations are often linked to the local telephone lines so that you can make calls from your mobile or handheld radio.

The Technician Class license also allows you to participate in the fastest growing aspect of ham radio. Packet radio allows direct computer-to-computer communication over public airwaves through personal computers linked to 2-way radios. Packeteers, as they're called, can send computer files to other computer-controlled stations even if they're unattended. Users have a special radio modem and a transmitter/receiver box containing a unique identifier or call sign that acts like a private telephone number. Needless to say, this mode of communicating bypasses the telephone company so it's free of charge. There are reportedly about 100,000 packeteers on-line already.

For additional information on ham radio licensing requirements, contact the American Radio Relay League, 225 Main St., Newington, CT 06111; (203) 666-1541.

Who's The Innovator?

Sony may have the reputation for technical innovation in consumer electronics, but Matsushita, the parent company of Panasonic/Technics, is mounting a serious challenge to the throne.

Two new projects under development by the company bear this out. One is a stereo system called the SC-FX1. In this system, the compact disc player, dual tape decks and tuner are configured in a laptop styling that includes a fold-up data display. Music is digitally relayed to an amplifier and speaker setup via infrared light. Range is about 22 ft. Communication between the infrared transmitter and receiver is line-of-sight only. The SC-FX1 is available in Japan, but U.S. marketing plans haven't been made.

Matsushita is also developing a sleep sensor that automatically turns off lights, adjusts air conditioners or turns off a TV, for example, as soon as you fall asleep. The sensor is basically a thin band of electronics that can be placed in or on top of a mattress. The sensor considers changes in the frequency of body movement to determine when you've left for dreamland. PM

Laptop stereo uses infrared communications link.

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You can call the PM computer any day between 6 pm and 8 am (only) Eastern time. The number is (212) 582-8369. Once you're on line, you can leave messages for specific editors, or direct inquiries and comments to a specific department. The department bulletin board also allows you to share your thoughts with other readers who call in.

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RESTORING STUCCO

BY BOB VILA, Contributing Editor

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UNITED STATES GYPSUM PHOTO

Stucco has always enjoyed popularity, especially in older homes. Though very durable, it can require periodic patching.

● Whether it's smooth and scored to look like stone, textured or pebble dashed, stucco is a decorative finish that adds an element of fashion to many old houses. As such, it should be maintained and restored in the best manner possible.

I'll begin where I usually do with a little bit of history. In the early days of our country, stucco was commonly used over masonry. Many brick and stone buildings were constructed to be stuccoed. Often smooth and scored to look like stone blocks, this decorative exterior was considered fashionable. Sometimes stucco was used to cover crumbling, damaged or deteriorated masonry. (So don't be tempted to strip off stucco to expose the underlying brick or stone unless a masonry expert with experience in such matters advises it.)

"Home Again With Bob Vila" is the title of our contributing editor's new TV show.

The material used in the late 18th and early 19th centuries was often a simple mix of lime and sand. Sometimes, additives like animal hair strengthened the mix. Some early stuccos also used natural cements after their discovery in this country in the 1820s. What was actually used varied from region to region and, of course, depended on the natural availability of local materials.

Most of the color in these early mixes came from the sand, which is the reason for early stucco's often beige or brown color. When color was added to the mix, it was in the form of natural pigments, like brick dust.

It wasn't until the 1870s, when portland cement became available in the United States, that the harder forebears of modern cement stuccos began to replace the early soft lime mixes. The change from soft to hard stucco didn't happen overnight. Since many artisans clung to their old preferences, it wasn't until the turn of the century that cement stucco became the norm.

It was about this time, the late 19th and early 20th centuries, that stucco was applied to wood frames or lath. This, of course, was the result of both the Tudor revival and the increasing popularity of bungalow structures.

As you can see, there are differences in the mixtures that were used years ago. To the old-house restorer, finding out what was originally used —and matching this mixture as closely as possible in strength, composition, color and texture—is the key to a successful restoration job.

Lime or cement based?

Many of the ingredients of early stucco either aren't available today or, if they are, have changed over the years. Because of this, it's nearly impossible to get an exact duplication of an original stucco. For example, the lime found today is different from what was used then. And sand, of course, varies depending on locality, with manufactured sand commonly replacing the rarer river sand in many historic mixes. But, with some trial and error (and a little luck), you should be able to come close enough to restore minor patches of failed stucco.

I imagine most readers are restoring homes built around the turn of the century, hence much of the original stucco is probably cement based. However, you can't go by date alone to determine what your house is wearing. A simple way to discover whether this decorative finish is lime or cement based is to put a piece of the old stucco in a glass of water. If it doesn't stay firm and most of it dissolves and becomes mushy, it's safe to assume you're working with a soft lime/sand stucco.

There are many different recipes for this soft stucco. One of the earliest I've seen, from the noted architect A. J. Downing, calls for two parts sand and one part lime. Today, you'd add a little portland cement to this mix for workability, along with animal hair if the original had it. For those patching

the harder cement stuccos, a mix with a high content of portland cement should be used. Some of the ones I'm familiar with call for this along with sand and hydrated lime. (For more information on historical stucco mixes, see the preservation brief mentioned at the end of this column.)

Don't be tempted to patch a soft lime-based stucco with a harder portland cement-based stucco (or vice versa). They aren't compatible. The materials' differing rates of expansion and contraction will generally cause your restoration work to crack.

Patching old stucco

In most cases, the spots where stucco has failed on your old-house walls will be pretty obvious. But there are situations where the lath may have pulled away from the wall, causing bulges or bubbles in the outer surface. After a thorough visual inspection, walking around the house and lightly tapping —with a rubber or wood mallet—any spots where you suspect underlying failure may reveal hidden spots of damage that should be repaired.

Don't try to tackle too large of a spot at once. Make sure the underlying surface is clean and sound, and test your mixture in an inconspicuous spot. You may have to alter your mix a bit to get the best match. Make sure, too, that your patches match any existing control joints, which are breaks in the stucco that allow for shrinkage and expansion.

If the stucco is applied to masonry, unless the underlying surface is badly spalled and deteriorated, you should be able to go over it again. Don't be tempted to use wire lath here. It's apt to rust over time, causing the stucco to fail. In most cases, original wood lath can be successfully replaced or covered with metal lath.

Stucco is commonly applied in three coats, although occasionally you'll see walls that are only wearing two. The first coat, called the scratch coat, is generally ¼ to ⅜ in. thick and is applied to metal lath, dampened wood lath or masonry. As its name implies, it's scratched or roughened so the second coat adheres. (Incidentally, I like to use a 6-in. square, cut from galvanized hardware cloth, as a tool for this.)

As soon as it's dry, which usually takes 24 to 72 hours, the second or brown coat, which is usually the same thickness as the first, is applied. In a plain, 2-coat application, this will be the final coat. More often, a third, or finish, coat of stucco tops it.

If that's the case, the brown coat, too, is lightly crosshatched to facilitate the final coat's adhesion. It's in this thin, top coat—often only ⅛ in. to ¼ in. thick—that any texture or design is added. It's applied after the brown coat sets.

If you've got more than a few small patches to repair, you may be better off calling in a professional. Trying to successfully stucco an entire wall is a different story than repairing a minor patch job here and there. Check with any local preservation groups or your state historic preservation office for masons that are sensitive to restoration issues.

Whether you restore your stucco walls yourself or hire a pro, having the right information on hand will help get the job done right. One publication I found particularly interesting is Preservation Brief No. 22, "The Preservation And Repair Of Historic Stucco," by Anne Grimmer. Published by the Preservation Assistance Division of the National Park Service, it's available for $1 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402-9325. Ask for GPO stock No. 024-005-01066-1. **PM**

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NEW CARS

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Oldsmobile 88—A New Image Builder

● Still seeking to redefine its image, Oldsmobile is rallying around a new battle cry—"Smart Contemporary Vehicles"—and presenting a new line of 88s to give it substance.

While the battle cry may not be the kind of slogan that makes strong men hurl themselves at barbed wire, we think the cars will definitely command attention. They are, in fact, smart and contemporary, a design that in some way overshadows Oldsmobile's luxury 98 series.

Riding the same 110.8-in. wheelbase as the previous 88 series, the new car is nevertheless a good deal bigger—4.1 in. longer, 1.5 in. wider, 1.1 in. taller. Some of this exterior increase has been passed along to front-seat passengers, but dimensions in the rear have actually shrunk a bit, partly to accommodate a 1.7-cu.-ft. improvement in trunk volume (from 16.0 to 17.7).

There's also a bit more power from GM's 3800 V6—170 hp, 220 ft.-lb. of torque, versus 165 and 210 in the current model—but there's a couple hundred pounds more car to haul around. The transmission is GM's 4T60E 4-speed automatic.

Like the current 88 line, there will be two trim levels, the 88 Royale and the Royale LS. Oldsmobile's sporty FE3 suspension package will also be available again, and antilock braking continues as standard equipment for the Royale LS, optional on the basic Royale.

Though it's nicely finished, the new 88's interior isn't as smart and contemporary as the exterior. The optional electronic instrumentation is difficult to read (the standard analog gauges are better), and the climate control switches are difficult to manipulate, particularly with the car in motion.

Seating is living-room soft, with little in the way of lateral support, and the thin-rimmed steering wheel that comes with the basic Royale conjures up images of, yes—your father's Oldsmobile.

On the other hand, the new line of 88s are big, comfortable, roomy cars with excellent ride quality and a smooth powertrain. Stir in an excellent job of styling, and you have cars that may very well help the Oldsmobile name stand out from the rest of the GM crowd once again.

—Don Chaikin

Distinctive styling of new Olds 88 reflects GM's current trend toward softer lines. Climate controls may prove tricky to operate.

Callaway Twin-Turbo Speedster

Corvette specialist Reeves Callaway has never been afraid of excess, and here's yet another proof. In addition to the usual Callaway Cars hotting-up treatment—twin turbos and intercoolers for the 5.7-liter L98 Corvette V8—the kids from Connecticut came up with their own wraparound cowl to crown the new Speedster.

Callaway claims 450 hp at 4500 rpm

Callaway-modified Corvette Speedster boasts 450 hp from twin-turbo V8.

for his latest twin-turbo Vette. Torque —613 ft.-lb. at 3000 rpm—is beyond massive, and it adds up to 0-to-60 in 4.5 seconds, quarter-miles in the 12.7-second range and a claimed top speed of 180 mph.

That capability, plus the car's looks, should be enough to earn traffic citations even when you're sitting still.

The cost for all this well-executed excess: $135,000. —*Tony Swan*

Mazda MX-3

From those wonderful people who brought you the Miata, here's a new sports coupe that's likely to turn almost as many heads. Besides the slick 2+2 bodywork, the MX-3 offers the distinction of the only V6 engine available in cars of this class. Offered in the upmarket GS version of the car, the new 130-hp dohc 24-valve engine also has the distinction of being the smallest V6 on the market at 1.8 liters. The basic MX-3 engine is a tepid (88 hp) version of the Miata's 1.6-liter dohc 16-valve Four.

Although the MX-3 probably won't be quite as quick as its prime competitors—the Honda CRX and Nissan NX Coupe—the V6 should be smoother than any powerplant offered in this class. And as far as quickness is concerned, 0-to-60 times in the 8-second bracket aren't exactly slow.

The MX-3's dimensions—96.3-in. wheelbase, 165.7 in. overall, 66.7 in. width, 51.6 in. height—are a little bigger than the current CRX and very similar to the new NX Coupe. The

(Please turn to page 100)

Paseo is Toyota's entry in pocket-rocket derby (see story on next page).

Slick Mazda MX-3 sports coupe offers industry's smallest V6 engine.

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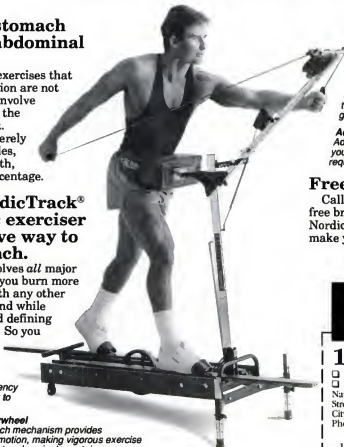

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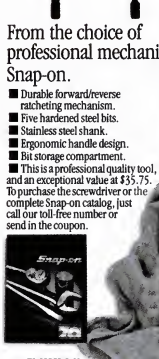

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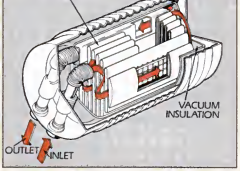
A Hot Idea From VW

● Cold starts are not only hard on mechanical parts, they're also the weakest point in a modern car's emissions performance. The cold engine runs very fuel-rich for the first mile or two to prevent stalling, making for high hydrocarbon content in the exhaust. Since it takes a couple of minutes for exhaust gases to get the catalytic converter up to its operating temperature, the converter can't burn off the excess hydrocarbons.

Volkswagen is planning to introduce a new device—called the Heat Battery—designed to preheat the engine before the driver actually turns the key. Plumbed into the cooling system, the device is basically a canister packed with small metal envelopes, each one filled with a salt compound that melts at about 165° F.

When the salt compound melts, it stores heat—overnight or perhaps as long as a weekend, according to VW—even when the outside temperature is near zero. The heat is released when a pump circulates cold coolant from the engine block through the canister and the salt crystallizes again, a process that takes about 30 seconds.

Once the engine is started, the fuel-injection computer can lean out the fuel-air mixture much sooner. Within 10 minutes or so, coolant circulation reheats the salt, and the system is ready to go again.



The system is designed to be easily triggered, perhaps by something as simple as opening the driver's door. A side benefit is the immediate availability of heat for the interior of the car.

VW says the Heat Battery might be available in some U.S. models as early as 1992.

—Mike Allen

ILLUSTRATION BY RON CARBONI

front-drive platform is basically the same as the Mazda 323, with struts all around, antiroll bars at both ends and speed-sensitive power rack-and-pinion steering.

Mazda will offer a choice of 5-speed manual or 4-speed automatic transmissions for both trim levels. The basic MX-3 has a disc/drum braking setup, while the GS version offers discs all around.

EPA mpg numbers run from 29/35 city/highway for the 4-cylinder with a 5-speed to 20/27 for an automatic GS. Window sticker numbers are expected to start at about $14,000 and top out at about $17,000.

—Tony Swan

1992 Toyota Paseo

Never one to be left out of any vehicle category, Toyota has joined the pocket-rocket derby for 1992 with the new Paseo coupe.

Billed as a 2+2, the Paseo, like the other newcomers in this segment, is basically a 2-seater with room in the rear for two very small people on very short trips. Realistically, the front seats are for people, and the rear seats are there to help save you money on your insurance—it makes it tougher for the insurance companies to call it a sports car.

As a 2-place car, the Paseo qualifies as roomy, with front seats that are both comfortable and supportive. Hip and leg space should safely handle robust 6-footers.

Conceived as an entry-level "sportster," the Paseo packs a lot of value in its estimated $10,000 price. The standard features list is the best we've read in some time. The only major options are air conditioning, alloy wheels, a sunroof and cruise control. You can also add a deluxe cassette sound system if you like, but the standard AM/FM/cassette setup should satisfy most.

Based loosely on the new Tercel platform, the Paseo doesn't have the go-power of some of the other cars in this category, but it's not exactly sluggish either. The new coupe is hauled by a 100-hp 1.5-liter dohc 16-valve engine—18 more hp than the Tercel—which definitely puts it in the sporty category.

The suspension, also Tercel-derived, is well matched to the engine performance. It seems conceived to favor ride quality over all-out handling, without being mushy or sluggish in switchbacks. Although it lacks the eager response of a Honda CRX Si, fun-to-drive is part of the package here, too.

Ride and styling notwithstanding, the Paseo's strongest suit may be its fit, finish, insulation, build strength

and overall engineering—in a word, quality, a traditional Toyota strength. Though there are cars in this expanding segment that offer more in the way of pure performance, the Paseo seems likely to hold its own in the virtues that count over the long haul.

—Rick Titus

Infiniti M30 Convertible

Announced too late to make our April convertible roundup, the new Infiniti M30 ragtop gives Nissan's luxury marketing division an edge on its competitors from Lexus and Acura—at least for the time being.

From window-level down, the M30 convertible is the same as its sports coupe counterpart—rear drive, propelled by a 162-hp dohc 24-valve 3.0-liter V6 mated to a 4-speed automatic transmission.

Convertibilization is handled by ASC's California branch, in Dominquez Hills. The top is a one-touch pushbutton operation. Holding the button down for 7 seconds will also raise or lower the windows.

The new ragtop carries a $31,000 price tag.

Porsche Plans

The long-anticipated replacement for Porsche's 944 series—called the 968—is expected to make its debut at this fall's Frankfurt Auto Show, with U.S. models scheduled to hit showrooms by January of 1992.

Judging by spy photos, the new car's styling bears a strong family resemblance to Porsche's 928 series. Like the 944, the 968 will use Porsche's 3.0-liter dohc 16-valve 4-cylinder engine, with output bumped from 208 hp to as much as 240.

Porsche also plans to improve output of the 928's 5.0-liter dohc 32-valve V8, from the current 326 hp to a potent 350. The latest improvement, due as a '92 model, will be called the 928 S5.

Fresh-Air Audi

After two years of enthusiastic response at auto shows, Audi has finally gone into production with a convertible version of its 80-series coupe.

When—or if—the Audi 80 Cabriolet will reach U.S. showrooms is an open question. Audi of America is weighing the car's U.S. sales potential against the extra costs associated with producing a car for the American market.

New VW Golf

Volkswagen's next-generation Golf will be bigger, smoother—and later, at least for U.S. buyers. Due for introduction in Europe this fall, the new Golf won't be ready for North American production until early 1992.

Assembly of U.S. models will be assigned to VW of Mexico, and new Golfs probably won't find their way into American showrooms until late next year.

Big Bucks Bentley

Although the new 12-cylinder Mercedes 600 SEL was the star of the recent Geneva Auto Show, Bentley drew plenty of attention with the surprise introduction of its new Continental R coupe.

Designed to provide more identity separation between Bentley and Rolls-Royce, the big (5340 pounds ready to roll) coupe is propelled by a turbocharged 6.7-liter V8. Rolls-Royce never releases horsepower numbers, but there's enough of it on hand to move the Continental along at 145 mph, which is where an electronic speed limiter cuts in.

The Continental R is the first body shell exclusive to Bentley in almost four decades.

If this kind of elegant exclusivity appeals to you, better get in line right

(Please turn to page 102)

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NEW CARS *(Continued from page 101)*

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Quad 2

The arrival of a 2-valve version of GM's 2.3-liter Quad 4 engine probably marks the beginning of the last chapter for another General Motors 4-cylinder, the tough old Iron Duke.

Oldsmobile recently announced the new sohc 8-valve edition of the Quad 4, which is slated to appear in economy versions of some of this fall's new cars. Officially called the Quad OHC, the new 8-valve 2.3 makes 120 hp at 5200 rpm and 140 ft.-lb. of torque at 3200 rpm.

Most recently labeled as the Tech 4, the 2.5-liter Iron Duke has been part of GM's powertrain arsenal since 1977.

Viper Production

Defying sluggish economic conditions and the gloomy prophecies of legions of automotive forecasters, the Dodge Viper V10 sports car is scheduled for production startup this November at Chrysler's New Mack Avenue Process Development Center in Detroit.

Although pricing is still a matter of speculation, Chrysler insiders say the sticker will show a bottom line of about $60,000. Production volumes, predictably, will be low.

For all its retrospective aura—the 2-seat roadster reminds us most of the brutish 427 Shelby Cobras from the mid-'60s—the Viper has served as a test mule for a number of Chrysler high-tech development programs, including materials, electronics and powertrains.

Impact Update

Although General Motors continues to resist announcing a date for the production of its new electric-powered car, Detroit-watchers are betting assembly operations will begin sometime in 1993 and cars will be in showrooms for the 1994 model year.

Based on GM's Impact concept car, the electric car will be the first product developed and produced by General Motors Electric Vehicles (GMEV), a new business unit in the General's vast empire.

While everyone associated with GMEV is mum about most aspects of the project, spokesmen have made it clear that the new electric won't be called the Impact.

Production will take place in GM's Lansing Craft Centre, the former Buick Reatta factory. **PM**

SMOKEY ON THE WATER

BY JOE SKORUPA, Boating/Outdoors Editor

$385.95

● Here's what some readers had to say the last time I wrote about personal watercraft (PWCs). "Folks who ride them go totally crazy," said a woman from Tulsa. A woman from the state of Washington called PWC riders "inmates who are totally uncontrolled." A man from California described them as "ear-splitting, environmentally destructive machines that are obnoxious and intrusive." And finally, a man from New Hampshire wrote, "PWCs are a package deal that come complete with jackasses at the throttle."

I'd like to notify the man from the Granite State that it's a misdemeanor in most places to call a policeman a jackass. More than 100 marine authorities in 35 states use PWCs for enforcement, emergency rescue and educational purposes.

Shock of the new

Next year POPULAR MECHANICS will be 90 years old, and, during this time, PM has witnessed the introduction of a vast amount of new technology. From a 9-decade perspective, it's easy to see that reaction to new technology typically follows a 3-stage pattern: 1. Enthusiasm, 2. Apprehension, and 3. Acceptance.

Personal watercraft are a perfect example. When the first athletically demanding models were introduced in the 1970s, youthful enthusiasts quickly adopted them. Their numbers were small, and the general public took relatively little notice.

Then, in the mid-1980s, sitdown models were developed. A person of any fitness or skill level could now ride a PWC, and sales boomed. Public attention boomed, too, and phase two—apprehension—set in.

Waterside landowners and traditional-minded boaters loudly objected to the proliferation of PWCs. Safety and ecological concerns were raised. Lawyers and lobbyists got involved. The result, in some cases, was that PWCs were banned on a great deal of water.

Now, the third and final phase has been reached, and the trend toward unfairly restrictive regulation appears to be ebbing. In this new era of acceptance, a variety of enforcement agencies have added PWCs to their fleets. These agencies range from police and sheriff's departments to fish and game agencies to beach patrols to parks and recreation divisions to emergency rescue units.

How, exactly, do policemen use PWCs? In Boston, the Metropolitan Police tout their Kawasaki Tandem Sport (TS) as a "unique weapon" for enforcing boating and PWC regulations, plus rescuing endangered swimmers. The police in Montville, Connecticut, discovered that their TS is far more effective as a rescue vehicle than the slower 17-ft. patrol boat. A California state park ranger reported that her TS gave her an element of surprise in enforcement and that educational contacts, a major component of her job, has more than doubled.

The police chief in Muskego, Wisconsin, found that his Yamaha WaveRunner is ideal for water patrol and rescue operations, especially for getting into shallow areas where duck hunters get lost or incapacitated. The Iosco County Sheriff's Department, in Michigan, used a WaveRunner to rescue a child more than a mile out in Lake Huron and learned that response time is much faster than using a full-size patrol boat. And, finally, in Delaware, the state marine patrol began using a WaveRunner in undercover operations, partly for enforcement and partly to defend PWC users against people filing complaints when nothing illegal has occurred.

Wet arm of the law

My first story on the unfairness of PWC restrictions ("Invasion Of The Water Snatchers," page 39, April '89) strongly opposed passage of a highly restrictive bill in the New Hampshire legislature. The bill was ultimately made law, and a long list of lakes were closed to PWCs. An equally long list of lakes imposed highly restrictive regulations.

At the time of passage, the bill received vociferous backing. After the bill was made law, the outcry was equally vociferous. In fact, the bill's sponsor, Roger Stewart, admitted he made a mistake in writing the law and was quoted as saying, "The ski craft (PWC) is a poor man's toy, and your rich landowners are the ones trying to get rid of them. . . I hate jet skis (PWCs). I just feel we are supposed to treat all things equally in this country, and I think they are picking on ski craft to unduly crucify."

Perception and reality. For several years, PWCs were perceived as being something they were not. The public, the police and some politicians have finally caught on. PM

one of the greatest things you could call an aviator.

The Habu era came to a close with the Blackbird's last high-speed flight, a record run between Los Angeles and Washington, D.C., flown on March 6, 1990 (see Tech Update, page 18, June '90). Lasting 68 minutes, 17 seconds, it concluded with a retirement ceremony at Dulles Airport. Many thought that was the end of the Blackbird story. But that may soon change.

Back, under new management

Years ago, when talk first circulated that the Blackbird might be retired, NASA expressed an interest in obtaining a few to add to its fleet of flight research vehicles. It lobbied hard and succeeded in gaining possession of two SR-71A pilot and RSO models, and the only SR-71B 2-pilot trainer in existence.

NASA hopes to use the SR-71 in much the same way it used its predecessor, the YF-12A, throughout the 1970s and early '80s. According to NASA pilots and flight test engineers I spoke to, the plane offers a platform for testing new materials and components in a moderately high-speed (2000 mph), high-temperature (500° to 1000° F) environment for longer periods than ground test facilities allow. Additionally, the SR-71 allows for testing under actual aerodynamic and heat-loading conditions.

Among the concepts driving NASA's interest in using the Blackbird is a hypersonic vehicle called the X-30, a single-stage, Mach-25 spaceplane that will take off from a runway and fly into orbit. To withstand the stresses of such a flight, the X-30 will require the development of materials and engines unlike anything ever used before.

The NASA test pilots scheduled to fly the Blackbird are Steve Ishmael and Rogers Smith. The flight test engineers who will accompany them not only possess aeronautical engineering credentials, but are excellent pilots as well. In fact, each is a California state champion in competition aerobatics. They also happen to be married to one another. Their names are Bob Meyer and Marta Bohn-Meyer.

Speaking with the NASA crews, I learned about the challenges, benefits, obstacles and opportunities they expect in flying the SR-71. When asked how the Blackbird might be a helpful tool, Meyer said, "I can see the aircraft providing a platform for development of new engine technology, structures research on new composites and simulated handling qualities of an SST." He also saw an opportunity to test emissions at high altitudes and to conduct sonic boom research.

As for challenges, Bohn-Meyer points out that "even though it's an older airplane, it is one of the most complex aircraft NASA has operated." Not only is Bohn-Meyer to be the first female crew member to fly aboard the Blackbird, but she is also responsible for managing all the SR-71 assets under NASA's control. Her efforts have been instrumental in the acquisition and storage of much of the needed support equipment: spare engines, computers, astro-inertial navigation systems (which can track stars, day or night), generators and engine-starting carts that contain two 500-horsepower car engines. (I still love the sound of those unmuffled Buicks winding up.)

NASA's greatest enemy in its efforts to get the Blackbird flying again may be time. Ishmael, NASA's lead pilot on the project, pointed out that "NASA is a methodical engineering organization," meaning they take the time to do things right. However, he adds, "The longer these complex, delicate assets sit idle, the harder it'll be to pull it off." With each passing week, more SR-71 expertise retires or transfers. "If we do this, we're going to do it so that everything is just right," says Ishmael. "The sooner, the better."

Training the next generation

NASA began air crew preparations for the SR-71 nearly two years ago. Crews flew to New York, where Singer-Link was conducting a $22-million renovation of the only existing SR-71 simulator for the Air Force. Operational SR-71 crews from Beale AFB had a chance to work with the NASA crews and give them a taste of what lie ahead. Since the Air Force had no further need for the simulator, NASA brought it to its Ames Dryden Flight Research Facility, located at Edwards AFB, California, in the summer of 1990.

The old simulator did a remarkable job of giving crew members a realistic sense of being airborne, but the upgraded version is even better. When you are focused on flying it, dealing with systems analysis and handling multiple malfunctions at Mach 3 and 80,000 ft., you honestly feel like it's the real thing. The instructor's panel is much improved, with updated computers and software that allow for additional normal and emergency procedures scenarios. The panel also offers more flexibility in working the crew

members individually or as a team.

Ishmael, who has some YF-12A experience, is developing plans for checking out NASA's SR-71 crew force. He's managed to garner the support of a number of former operational crew members, some still on active duty, and others recently retired from the Air Force. They have all given him their views on how to approach the training.

Ishmael stressed the importance of using the simulator to practice emergency procedures. He said that unlike newer aircraft, the SR-71 requires the air crew to play a more integral role in systems analysis and corrective action.

One still unresolved decision that will affect the training program is whether or not to use air refueling on NASA flights. We discussed the pros and cons of taking off with a light fuel load and going straight to an airborne tanker, the way we normally did it in the Air Force. The alternative is taking off with lots of fuel and accelerating immediately to high speed and altitude.

Air refueling was an absolute necessity in the operational world, where we might have to cover several thousand miles on one flight, day or night, and in any kind of weather. NASA will closely structure its flights to focus on narrower goals with tightly controlled parameters. Thus, the NASA missions might not require air refueling, except in an emergency.

Meyer and Bohn-Meyer began their simulator work in October 1990 and have received instruction from a number of Air Force crew members. They each had about 70 hours of simulator training when I interviewed them, and they expect to have 150 hours each prior to their first flights. Maj. Randy Shelhorse, one of the last operational SR-71 RSOs, recently devoted a week of his vacation time to training the NASA flight test engineers. Shelhorse told me he couldn't believe how fast the two NASA engineers were learning this complex aircraft. He was very impressed.

NASA has discovered that a lot of people who used to work with this airplane have volunteered their services to assist in flying it again. In her role as manager of SR-71 assets, Bohn-Meyer told me she gets several calls a week from engineers, technicians, pilots and RSOs located all over the country who have offered to help NASA fly this remarkable machine. Many of them do not expect payment.

This is the Habu tradition. And it will help ensure the mystique and magic of the Blackbird remain with us for a long time to come. PM

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WIDE RECEIVER

BY STEPHEN A. BOOTH, Contributing Editor

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● If you've got $7000 to spare, you can buy the TV of the future today. But you'll have to convert the dollars to francs and do your watching in France, at least for the time being.

By the time you read this, the first widescreen TVs capable of displaying high-definition images will be selling in Europe. The new sets hail from France's Thomson Consumer Electronics, corporate parent of the RCA and General Electric brands.

True high-definition television won't come to Europe until 1995, but the Thomson Space System can deliver enhanced TV pictures in a widescreen format today. And, although the tuners in the 34-in. set receive only European PAL and SECAM broadcasts, the Space System can display images from VCRs, videodisc players and camcorders that use the NTSC system employed in the United States. Fitting the sets with an NTSC tuner would not be very difficult.

Accordingly, Thomson might bring the widescreen monitors to the United States under the RCA brand, possibly in time for the '92 Olympics. The company is likely to do so if the Federal Communications Commission does not specify standards for an enhanced NTSC format that could be broadcast until true HDTV arrives.

For the record, "true" HDTV is generally defined as having a picture whose width-to-height ratio is 16-to-9 (1.77-to-1)—about a third wider than current 4-3 (1.33-1) screens and closer to the Cinemascope-like proportions of movies seen in a theater. Additionally, HDTV would render more film-like images by doubling the number of scanning lines that make up a TV picture, from 525 to 1050 in the case of NTSC (625 to 1250 in Europe). Finally, proposed HDTV systems would deliver CD-quality digital sound.

The first set in Thomson's Space System line employs a virtually flat tube to display what the company calls "cinema format" images having a width-to-height ratio of 16-to-9. In terms of viewable dimensions, the tube measures about 34 in. diagonally, 30 in. wide and 17 in. high. Although picture height is just about an inch more than that of a 27-in.-diagonal set in the 4-3 format, the Space System tube is about 8 in. wider.

The Space System offers four different display options. Letterboxed programs, frequently broadcast in Europe but also available on tape and disc, are displayed in their full cinematic width across the screen—but without the black bands that would appear at the top and bottom of a 4-3 set. This is called the Cinema mode. Additionally, programs in the 4-3 format from any source (broadcast, cable, prerecorded video) can be displayed in one of three ways.

"GLORY" COURTESY OF RCA/COLUMBIA HOME VIDEO

In the Standard mode, you can place a 4-3 picture in the center of a widescreen tube. The picture will be framed by black bands on the sides. Optionally, the 4-3 image can be shifted to the left side of the screen while three smaller 4-3 "picture-outside-picture" (POP) images are stacked to the right. You can use the POPs to watch another program, scan channels or display freeze-frame stills.

In the Wide mode, the 4-3 image is zoomed up to full 16-9 proportions of the TV screen. Cropped and zoomed is a more accurate description because you lose a small portion of the image at its top and bottom when the 4-3 image is blown up to fill the width of the 16-9 tube. Is the loss objectionable? This depends upon the composition of the source material. It's possible that textual material such as subtitles might be partially obscured.

The virtually flat Space System tube, now made in Italy, also can be produced in Thomson's U.S. plants. At a Paris demonstration, I found the picture especially good. Because it is an HDTV-ready tube capable of displaying the 1250 scanning lines of the proposed European system, the Space System now functions as an improved-definition set by digital line-doubling. Sound is superb, too. A 2-channel amp with 70 watts per side drives the five built-in

Canon's L1 camcorder can also use photography lenses (see story on page 108).

speakers, including a bass subwoofer. The set also incorporates a surround-sound circuit with its own 20-watt amp for external speakers.

If and when the Space System comes to the United States, Thomson says it will cost about 30% more than 35 in. 4-3 sets.

Duke Goes 3D

If there were a movie about it, the title would be "The Thing That Wouldn't Die." This sums up America's fascination with 3-dimensional imaging. Now, that icon of American values, John Wayne, will be appearing on your TV screen bigger than life in 3D.

For the first time in more than a decade, TV viewers will get to see "Hondo"—a Western the Duke himself produced in 1953. For legal reasons, the movie has been out of circulation for some time—and isn't even available on video. Duke shot a 3D version of the movie simultaneously with the flat film, and this is the version that will be syndicated for TV from June 24 through 26.

The 3D film print has been enhanced for TV and video viewing by Spatial Technologies, of Hollywood, California. The company's process, called Natural Vision, separates foreground subjects from the movie's background to create an illusion of depth. One advantage claimed for this system is that the movie will appear normal when viewed without special 3D glasses—that is, with none of the fuzziness and distorted colors that sometimes afflict 3D movies produced by the conventional anaglyphic method. Check your local TV listings to find out when "Hondo" will air and where to obtain the 3D specs.

(Please turn to page 108)

John Wayne returns as Hondo this month in a special 3D TV broadcast. The film was shot with a special 3D camera (left) in 1953 and hasn't been seen in that format since.

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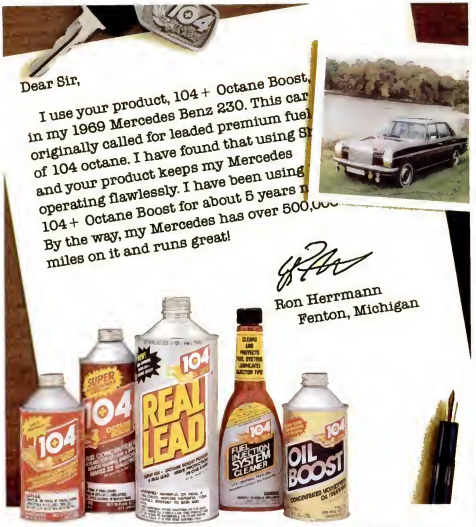

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HOME VIDEO

(Continued from page 107)

Camcorder Currents

Electronics companies make technologically sophisticated camcorders, but I've frequently noted that the traditional photography companies bring the more creative sensibilities to their video moviemakers.

Until now, camcorder users have not had the option of changing lenses as still photographers do. Recently, electronics and photography manufacturers created a standard for an interchangeable lens mount. This means camcorders of the future will be able to accommodate a variety of specialty lenses—fisheyes, supertelephotos and so on.

First on the street with this camcorder of the future is Canon. The company's L1 is a high-band 8mm model whose video wizardry adds some tricks to Canon's top-of-the-line A1 series. Where the L1 departs from the A1 is photographically: The L designation indicates lens interchangeability.

Out of the box, the L1 ($2995) comes with a 15X zoom lens. But this can be removed and replaced with a faster (more light-sensitive) 8X zoom —and other video lenses yet to come. Meanwhile, the L1 can use lenses from Canon's EOS line of autofocus 35mm SLR film cameras. All that's needed is an adapter ($250) that mates the EOS lens to the camcorder's lens mount.

This option of using 35mm camera lenses is significant for two reasons. For one thing, the sheer variety of SLR lenses opens new worlds of optical creativity to the camcorder user. Just imagine how a super-wideangle lens can add zest to scenes in your home movies. For another thing, 35mm lenses mounted on a camcorder give you unprecedented reach. Whatever the focal length of the camera lens, it's multiplied four to 5.3 times when attached to a camcorder. This means that a normal 50mm lens becomes a 200- or 265mm telephoto. A 300mm telephoto stretches to a 1200- or 1590mm optic.

Back in the realm of conventional fixed-lens videography, Canon is offering another first. Model H850 ($1899) can be best described as a postproduction special-effects studio disguised as a camcorder.

What makes this 8mm camcorder unique is its use of add-on microprocessor chips that superimpose graphics, music or both on your footage. The chips slip into two receptacles on the side of the H850, next to buttons that let you call up a design or a ditty as you're shooting.

One graphics chip comes with the camcorder. Half a dozen other graphics chips and four music chips are available at about $20 each.

At this writing, there are 56 different graphics and 32 songs. If these don't suit your purposes, you can draw your own artwork and store it in the H850's digital superimposer for insertion while the camera rolls.

Fuji's first camcorders for the United States bring something extra to the party, too. The Fujix-8 F60Wide ($1250) is an 8mm model with a 6X zoom and built-in wideangle conversion lens. At the push of a button, the lens converts from a standard to a wider perspective that effectively doubles the camcorder's field of view.

Perhaps the most innovative feature of the Fujix-8 F60Wide is its Multi-Action Handgrip. In its folded position, the grip works as a carrying handle. Unfolded, it functions like a pistol grip to help you steady the camcorder during shooting. Also in the unfolded position, the handgrip can convert into a low-profile tripod. When so deployed, you can use the infrared remote control to operate the camcorder while you get into the movie yourself. **PM**

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SCIENCE

ANTI-GREENHOUSE TECH

BY ABE DANE, Science/Technology Editor

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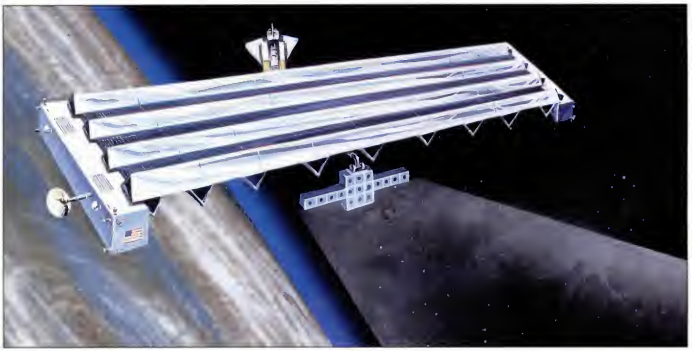


● What if the greenhouse effect is worse than we think? What if we've already pumped enough carbon dioxide into the atmosphere to bring a runaway heat wave that will flood coastal cities, wither crops and wreck our economy?

Although unlikely, such a scenario is within the range of possibilities presented by the latest climate data. So far, supercomputer models have determined only that there is global warming in our future. How bad it will be is anyone's guess. But if worst-case projections are true, simply cutting output of greenhouse-inducing pollutants won't be enough. The only way out of the greenhouse will be the way we got in—through technology.

So far, methods of intervening directly in the mechanisms of global climate have received limited, and usually skeptical, attention from scientists. But an as yet unreleased study by the National Academy of Sciences is reported to weigh several such options and to judge some of them worth further consideration.

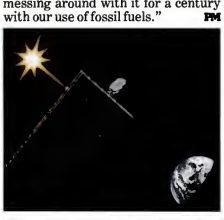
The most radical concepts are satellites that would reduce the amount of solar radiation entering our atmosphere. According to Lyle M. Jenkins of NASA's New Initiatives Office at Johnson Space Flight Center, space offers the unique advantage of access to the global climate system as a whole. "You're able to view and interact with very large areas," he says.

The simplest approach would be to erect a giant shade between the Sun and Earth, where it would act as the Moon does during a solar eclipse. Of course it would be on a smaller scale, requiring that roughly 100 sq. km of lightweight material such as mylar be unfolded to have a cooling effect.

An alternative concept would use space simply as a location for energy production, providing a substitute for CO_2-producing powerplants on Earth. Although the idea of using orbiting photovoltaic cells for electricity that could be beamed to Earth is not new, it is getting new attention as photovoltaics grow more economical.

Other orbiting equipment (shown above) could help save the stratospheric ozone layer. Now threatened by chlorine from chlorofluorocarbons used in air conditioners and spray cans, the ozone shield prevents cancer-causing ultraviolet rays from reaching Earth's surface. Theoretically, aiming a solar-powered microwave or charged-particle generator into the upper atmosphere could prevent ozone destruction by neutralizing chlorine atoms.

The main problem right now, according to National Academy of Sciences sources, is that the costs of getting the necessary equipment into orbit are prohibitive. But next-generation spacecraft based on the Advanced Launch Development Program or the National Aerospace Plane could bring those costs down by an order of magnitude. For now, Jenkins believes it's important to gather hard data on how space technology could help the environment. "There's knee-jerk response to messing around with Mother Nature," he says. "But the fact is that we've been messing around with it for a century with our use of fossil fuels." PM



The greenhouse is forcing a new look at solar-powered satellites, such as this NASA concept.

(Continued from page 49)

was forward air controllers flying F-16s right over the target zone. Referred to as Fast FACs, these were experienced pilots who made high-risk, low-altitude passes over the battlefield, dropping phosphor flares to mark targets. Keeping track of what had been knocked out and what hadn't, these pilots would coordinate attacks in their area of coverage, reducing the danger of collisions in the often swarming skies. Similar duty was performed by pilots in slower OA-10s, versions of the A-10 tank killer carrying phosphor flares instead of bombs and missiles.

When ground attacks came into the picture, the Army relied on transplanted Air Force men called air liaison officers or ALOs to coordinate air support. In an effort to keep the deadly confusion of battle to a minimum, the ALOs lived with the troops, staying in radio contact with the ABCCC from HumVees or helicopters.

While the ABCCC with its FACs and ALOs specialized in coordinating air-to-ground activity close to the front, AWACS planes with their long-range radar guided other planes deeper into enemy territory. Beyond what was known as the Fire-Support Coordination Line (FSCL), the Air Force was authorized to attack without consulting the Army. And that was where AWACS was particularly important. While designed primarily to direct air-to-air combat, the AWACS' ability to track up to 250 aircraft over a 58,000-sq.-mile area proved crucial in many phases of the air war, vectoring planes in for strikes at Scuds, airfields and other targets deep into Iraq.

Data from AWACS radar was also shared with TACC, ABCCC and other command centers. There, the AWACS air picture was merged with ground data from the E-8A Joint STARS aircraft (see Science, page 118, April '91), which peered across enemy lines with its phased-array radar.

Numerous other sources contributed to a tack-sharp view of Iraqi activities. The TR-1A, an updated version of the 1950s U-2 spyplane, beamed sensor data directly to commanders, both in the field and back at headquarters. While with more imaging satellites in orbit than at any time in the past 20 years, space-based sensing played an unprecedented role.

Eyes of the storm

Perhaps more remarkable than the extraordinary resolution and sensitivity of today's orbiting sensors was the speed with which their data reached the hands of those who need-

(Please turn to page 113)

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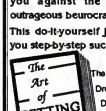

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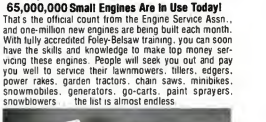

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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor

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Ford Plans Fwd Midivan For '95

● Ford plans to introduce a midsize van as a 1995 model.

Bigger than the Aerostar, but smaller than the full-size Club Wagon series, the new van will incorporate several departures from Ford's current small-van lineup. For one, the van will use the Taurus front-wheel-drive system, including a 3.8-liter V6 and a 4-speed automatic transmission. Front and rear track will be a couple inches wider than the Aerostar, a feature that shows up clearly in prototype mules, which have fender flares attached to Aerostar bodies.

The new vans will replace the Aerostar line at the top end, while Ford plans the new Mercury Villager, developed as a joint-venture project with Nissan, to fill in at the lower end of the Aerostar range.

All the advantages of front drive will be exploited in the new van, including a flat floor, low load height and a body design that can easily accommodate a stretched model.

Tow ratings may be one shortfall of the new midivan. Front-wheel drive doesn't lend itself to towing, and the Aerostar's 4.0-liter V6 matches the 3.8 for torque and has more peak hp.

Neon News

Neon has been used to attract attention for decades, but it may see new automotive applications in the near future. Automakers are experimenting with neon bulbs for stoplights, and the results are promising.

The neon gas replaces a fragile filament in the traditional lightbulb, and that means longer life for the light.

Also, red neon could eliminate the need for colored lenses. Neon bulbs will fit in spaces that today's bulbs and reflectors can't, and that could lead to more interesting shapes for the car's design. While some of these same traits apply to light-emitting diodes (LEDs), neon bulbs are considerably brighter and may be less expensive.

On The Bubble

Side impact protection rules will get tougher in the next few years as the federal government moves to cut down on accident injuries.

As one answer to the stricter rules, a new type of padding is being developed for door interiors. Akin to bubble wrap packaging material, the new padding will dissipate impact energy by forcing air through small openings in the bubble pack.

The technique is appealing as a lightweight, compact answer that fits in well with the space restrictions of a door's interior. Low weight also means no adverse effect on fuel economy, and the material itself should be relatively cheap for industry suppliers to manufacture.

A Shocking Story

Those fluids that change viscosity when they're subjected to an electric charge are still under development for use in shock absorbers.

The fluids are called electro-rheological types. When charged with an electric current, they become thicker —more viscous.

Theoreticians suggest that they'd lend themselves to use in suspension systems that would combine both passive and active features. The passive would be a standard suspension setup. The active would have the electrically reactive fluids in the shock absorbers so that damping could be increased or decreased to meet driving conditions.

Thicker—more viscous—fluids would stiffen the suspension for avoidance maneuvers and hard cornering. Less viscosity would soften the suspension, providing a softer ride.

1992 Eldorado

Like the new Seville sedans, Cadillac has abandoned its hard-edged look for the new Eldorado, due for introduction this fall.

Our spy shot of this Eldorado prototype reveals a slanted C-pillar and lines that are softer than the current Eldo.

The redesigned Eldorado will come to market with the same 200-hp 4.9-liter V8 and 4-speed automatic used in the current model. Cadillac plans to debut its long-awaited Northstar V8 engine in the next-generation Allanté. PM

For '92, Eldorado will feature rounded body lines and slanted backlite.

(Continued from page 111)

ed it. One example was a program called Constant Source, which instantaneously sent satellite images to transportable terminals used by commanders in the field.

Another was the warnings of Scud launches provided to Patriot antimissile crews and civil defense officials by Defense Support Program satellites. When a Scud's exhaust was picked up by the satellites' infrared sensors, it was transmitted simultaneously to a ground station in Australia and via satellite to the Air Force Space Command's Cheyenne Mountain headquarters. After verifying the launch, computers at those locations predicted an impact area and sent a warning back to the Persian Gulf.

Since the DSP system was designed for the much longer flight times of ICBMs, the 5- to 7-minute flight of a Scud allowed only last-minute warnings. But streamlining the system later in the war produced some improvements.

Another reconnaissance innovation that set Desert Storm apart was lower tech than a satellite, but in many ways more flexible. Remote-controlled airplanes known as unmanned aerial vehicles (UAVs) are an area where the U.S. efforts have been sporadic. But their potential was made plain when the battleship *Missouri* used them to direct its big 16-inchers.

Designed by Israel Aircraft Industries and manufactured under license by the U.S. firm AAI, the Pioneer system had been hastily retrofitted to the ship right before the war. Propelled to speeds between 60 and 95 knots by a 2-piston engine, the craft can overfly targets as much as 135 miles distant at altitudes between 1000 and 13,000 ft. A payload of TV or infrared sensors sends back images day or night. Commanders reportedly were pleased with the results.

Land forces made use of an experimental UAV, which happened to be under testing with the 82nd Airborne when they deployed. The tiny Pointer drone could be carried in two 40-pound backpacks and set up in 5 minutes. Made of balsa and composite materials, the battery-powered plane patrolled perimeters and performed other duties normally handled by infantry scouts. Troops compared it to having a 500-ft.-tall soldier with binoculars on their side.

In fact, the forces on their side were far subtler and more pervasive than that. After years of troubled and uncertain development, during which they were some of the least understood and most maligned of military systems, the weapons of the electronic battlefield have come of age. **PM**

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AUDIO

STEREO TESTING

BY FRANK VIZARD, Electronics Editor

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PM PHOTO BY BRIAN KOSOFF

● Evaluating an audio system can be a frustrating task. Most people don't have access to a lab full of test equipment. And if you rely solely on your ears, it can be difficult to pick out certain performance characteristics.

While generally not available in record stores, a number of labels do offer test compact discs. In general, they are of two types. They either are comprised solely of test tones or they combine test tones with a variety of musical selections.

The test tones can be used to measure performance at various points along the audio spectrum. For example, you can judge how good bass response is by checking the frequency at which bass first becomes audible. Other tests examine left and right channel separation, intermodulation distortion and other criteria.

The electronic industry's standard test disc is one developed by the now defunct CBS Technology Center. Called CD-1, the disc is available by writing CBS Special Products, P.O. Box 3000, Carrollton, GA 30117. The cost is $48, plus $3 handling.

While the CD-1 is the industry standard, it does not include every test you can make. A French label called Pierre Verany has a 2-CD set that includes tests not on the CD-1. One series of tests, for instance, measures the CD player's ability to correct for dropouts or flaws in a CD. Some CD players have better error correction circuitry than others, and not all CD players react to flaws in the same way.

The Verany test disc also includes a variety of sound tracks that are also useful for testing purposes. Each sound track is designed to test certain reproductive capabilities in the audio system. Verany also has a 1-disc test package as well. Expect to pay about $30 for the 2-disc set.

Another source of test discs is Denon. The company offers two discs, each costing $20. One disc, No. C39-7441-EX, includes some basic tests and a variety of musical passages. The second Denon test CD, No. C39-7147-EX, offers a greater number of test tones for more detailed analysis of specific frequencies and various other technical capabilities. Write to Denon, 222 New Rd., Parsippany, NJ 07054.

CD to tape

If you're the type who makes tapes from compact discs for use in a personal tape player or car audio system, you may be perplexed as to where you should set the record levels on your tape recorder.

TDK has taken the guesswork out of recording with a CD called "The Ultimate Guide To Recording From CDs." The most useful part of the disc is a series of 54 test tones for 19 types of music. Each tone corresponds to the ideal recording level for one of three TDK blank cassette tapes.

While the recording levels here are optimized for TDK tapes, you won't be going too far astray if you use similar tapes from other major brands as well.

Using the TDK disc is simple. First, you match the musical genre with the tape type for the appropriate CD track number. Then, with the tone playing, you set the record levels so that the level meters on the deck read 0 dB. Replace the TDK disc with the one you want to record and start taping.

The TDK disc also contains some narration and music to illustrate some of the basic tenets surrounding cassettes. To get the disc, send $4 to Box PM, DBA Productions, 50 W. 17th St., New York, NY 10014. **PM**

Test tones correspond to best record levels for easy taping of any musical genre.

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MOTORSPORTS

PM RACING 1991

BY TONY SWAN, Automotive Editor

— $385.95 —

PM PHOTO BY GEOFFREY HEWITT

● After several seasons of endurance racing, we're shifting gears for '91 to Sports Car Club of America Showroom Stock Nationals.

This promises to be very interesting on two counts. First, there's the adjustment of going from multihour grinds to the intensity of 45-minute sprint races. Being around at the finish is still important, of course, but nursing your machinery isn't really a big part of the equation.

Second, showroom stock racing at this level is about as real-world as racing gets. Unlike the stock-appearing cars of the IMSA Firehawk and SCCA Escort World Challenge endurance series, SCCA showroom stock racing at the Nationals level allows no modifications whatever, aside from safety installations—a roll cage, window net and fire extinguisher.

Consequently, it's hard to imagine a more realistic test of a car's true performance capabilities than this.

The Nationals system

National points racing has long been the core activity of the Sports Car Club of America, and this promises to be true for the foreseeable future.

Here's how it works. The SCCA has the country carved up into eight geographic divisions. Throughout the racing season, each division hosts several racing weekends. There are a number of races at each of these meetings, entailing all of the club's 23 National racing classes.

Points are awarded on a basis of finishing position in each of the racing classes. At the end of the season, the top competitors from each class in each division are invited to SCCA's national championship runoffs, held annually at Road Atlanta.

This perennial week-long showdown is one of the best racing shows on Earth, involving some 450 to 500 drivers, the best of SCCA's 4500 National license holders.

Our objective is to join this exclusive group.

The car

Our mount for this campaign will be a 1990 Oldsmobile Cutlass Calais Quad 442, which will compete in the Showroom Stock A (SSA) class.

SSA includes some tough contenders: the Mitsubishi Starion Turbo, which took the top-three spots in last year's national runoffs; the Shelby CSX; the Mazda MX-6 GT and the Mitsubishi Eclipse/Plymouth Laser/Eagle Talon.

But we've always been impressed with the response of the H.O. Quad 4 engine—180 horsepower at 6200 rpm, 160 ft.-lb. of torque at 5200 rpm—and hope this will give us an edge getting off the corners.

The tires

We also expect that response to be enhanced by our tires, the BF Goodrich Comp T/A R1. Besides upgrades in compound and tread pattern, this new performance tire has a unique construction technique, which makes one sidewall (the inner) stiffer than the other.

This innovation helps the tire's contact patch maintain a more uniform grip during hard cornering.

R1-shod cars claimed three of the four Showroom Stock pole positions—SSGT, SSB, SSC—at the SCCA's Road Atlanta runoffs last year, and carried Boris Said's SSGT Camaro to a national championship.

We hope to add SSA to this distinguished record. We'll file a progress report in our August issue. Stay tuned. PM

ACKNOWLEDGEMENTS

While we expect to add sponsors as the season rolls along, we want to express our appreciation to the following firms for their contributions to the PM Racing Quad 442:

- Oldsmobile: Quad 442 project car.
- BF Goodrich: Comp T/A R1 tires.
- U-Haul: car transporter.
- Competition Graphics (Farmington Hills, MI): numbers and logos.
- Burne Oldsmobile (Scranton, PA): maintenance support.

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HERE'S HOW IT WORKS:

It is a concept that is so SIMPLE and so fantastically
INCREDIBLE that it would be hard to make a mistake, even if
you tried. Perhaps the most important aspect of this method is
it's overwhelming success rate. It's simple, effective, powerful
and fun to do. It definitely eliminates all the hard work, time,
and money which is usually required and does it in a way that
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SHORTEST AND SAFEST way of making big money that I
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AND OVER AND OVER AGAIN. It will make an instant believer out of anyone who sees it for the first time - IT'S EASY AND IT PRODUCES MONEY-FAST!

If you can follow my simple instructions, page by page, you'll be in for an excellent surprise. This can be done at your own convenience while still keeping your regular job. You can operate my money making plan part-time, weekends only, or even full-time and still make a ton of money.

Forget about work and forget about risk . . . there is little of either involved. If you desire to earn money almost effortlessly, without scheming, selling, or borrowing-without giving up your precious time with your family or putting a dent in your social life. The money will be yours, you can spend it on anything you like . . . exotic vacations, luxury cars, prime residential real estate, or anything . . . even starting your own company or business.

This technique is perfect for someone without a lot of money to invest because you can and should spend less than what amounts to $1.00 a day. Risk is virtually eliminated. In fact, there is so little risk involved I consider it almost insignificant.

Everything will be carefully disclosed to you in precise detailed steps, clearly, concisely, and in an easy-to understand manner. I'll send you the facts, actual working material, and instructions you need to make money at once. There is nothing magical about it. It's for anyone "now" and anyone, even a high school student, can learn to do this in approximately 30 minutes.

THAT'S IT - IT'S THAT EXPLOSIVE!

No more guesswork, no more hassles . . . nothing but straight, easy income. This has got to be the most valuable piece of inside information that you can buy - in my opinion, it's priceless! The money will start coming in directly to your home or office in only a matter of days. Every penny is yours to keep! It all comes in "cold cash," ready for you to spend right now. Spend only a little each week (or a few dollars keep up at home and watch your money grow!) or a few dollars keep coming in (instead of out) for a change . . . THAT'S ALL I DO! Anyone else receiving this money-making plan can do it, too. Anyone else receiving this money-making plan can do it, too.

IT'S SIMPLE AND VERY INNOVATIVE!

This technique can be used by anyone, anywhere, with a tiny bit of ambition. It's such an enjoyable way to make money, most people won't call it work-it's perfect for both men and women alike. Also, I don't care about your age, there is no physical limit involved-(you could be 19 or 90 years old). I don't care about where you live or what you do for a living or even if you are retired now. Your education level won't matter either-these things are totally unimportant. It's being done by people from all walks of life; plant workers, office people, shut-ins, grandmothers, farmers, plus students, accountants, salesmen, engineers, government officials, and lawyers. Who cares who you are or what you do? My program works for itself. It is responsible, exciting and extremely fun to do . . . nothing dirty or distasteful. You also won't have to write a book or spend a lot of time selling something (I call that work-this isn't!) All joking aside . . . if you spend more time on this, you are working harder! I do this, I don't believe it, while watching the news programs on television at night.

ABSOLUTELY FOOLPROOF!

This plan will show you how to take in more money in a day than you now earn in a week . . . more money in a month than you now earn per year, and more money in a year than most people could ever thought possible. Enjoy your life in a way that most one ever thought possible. Enjoy your life in a way that most people will only dream about. It would stagger one's imagination, while they are making only a fraction of what you will be making by WORKING ONLY PART-TIME, at home.

I apologize for having to charge $20 for my program, but the report and materials are not really expensive when compared to what you will definitely gain! It's my sincere desire to help you accumulate money for yourself by sharing my research. However . . . I cannot afford to lose money by making my work available to others. Please, don't tell me that just $20 will break you or that it's too much to spend on yourself, your quality of life, or your family. (Over a year's time, this works out to only 5¢ a day-that's less than a cup of coffee a week!) If you are having trouble affording that, then you need this information right now-AND FAST! You are going to COME ALIVE with excitement!

I can understand that the enclosed material sounds a bit far-fetched. Part of your skepticism probably comes from not knowing who you are dealing with. I am not a "wheeler-dealer," or a "high-roller," or a financial "wizard." I'm just an honest, hard-working business man whose parents were simple and hard-working people as well. My father taught me to give an "honest day's work" for an "honest day's pay."

MOST PEOPLE WILL NEVER KNOW THAT SUCH A SYSTEM EXISTS - BUT IT DOES!

I have taken hundreds of hours to check this out, double-checked for mistakes, and then checked again. I have checked this method against charts, financial advice, newsletters and it is far superior to anything I have tested against. Since then, I have continued to use this method. Every time without exception, I have discovered more. And, there is no limit to the number of times you can use this technique. It just makes you more money than anything else available. Don't let anyone tell you it isn't possible. I've tested it 12 times . . . believe me, it works and keeps on working without very much time, money or effort needed!

As you can tell by now (to say the least), I have come across something pretty darn good. All in all, as I said at the beginning, I've discovered what I think is the "sweetest" money-making secret you could ever imagine. . . . AND SIMPLE TO USE - SIMPLE TO UNDERSTAND . . . AND SIMPLE TO APPLY . . . I've never been more certain of anything!

It's a wonderful feeling to be writing to you for the first time in my life I wake up happy every morning for a change. It is happen-ing to others, why not you? Be the first to put this offer aside, right now would be a definite shame. If you put this offer aside, without ordering now, we both lose out. I'll miss a modest sale and the pleasure of giving you success: you, on the other hand, will likely throw away the greatest chance you've seen to "finally make it." You may never know how you need it for emer-to have $120,000 in the bank anytime you like owning three luxu-gencies. You may never know what it's like owning three luxu-ry cars valued at $130,000. And, you may forever wonder what it's like to own a prestigious home worth over $360,000 in what the state.

I know you are interested in a method of obtaining "immed-ate extra income." SO, PLEASE, THIS TIME, ACT! IT'S WORTH SEEING!

ROCK-SOLID GUARANTEE

Put my money secret into use. Be able to solve all your money troubles. And if for any reason you are not totally excited about the results you may return my material for a full refund of your money!

It's working for me, it has worked for others, and it will definitely work for you! I've spent a lifetime sharpening and refining this program. What you will receive is the "best of the best" - IT'S AS GOOD RIGHT NOW AS ITS EVER GOING TO BE!

YOU CAN LAUGH AT MONEY TROUBLES FOR THE MONTHS TO COME!

Nothing . . . (I'll repeat) . . . nothing . . . is as thrilling as watching this darn program work while know you are getting wealthy! Nothing!

As always, the choice is yours. The decision that you right now can determine how rosy, or how bleak that future will be. So please, make the wise decision and fill in the form below, right now. You're going to be really glad you did!

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A Secret That Will MAKE YOU RICH

'You Can Laugh at Money Troubles – If You Follow This Simple Plan'

Before turning this page, you'll be reading about making lots and lots of money with very little work involved-GUARANTEED! If you are poor, as I once was, this secret will make you rich; if you are already rich, this secret will make you richer. (PLEASE READ ON!)

As unbelievable as it sounds, I have actually developed an "exclusive-information package" that is so powerful it's guaranteed to END YOUR MONEY TROUBLES-FOR THE REST OF YOUR LIFE! I'm doing it . . . others are doing it . . . why not you? I'll show you exactly how it's done and provide you with SPECIFIC "INSIDE" INFORMATION. You will not be able to believe how amazingly simple this is to actually do. Plus, what it costs you to test this for yourself (so you can be sure) amounts to only about $1.00 a day, over a years time!

HERE'S THE SECRET

Now-ANYONE (including yourself) can very easily earn enormous sums of money in THEIR SPARE TIME, in the privacy of THEIR OWN HOME, and without having to step foot out of one's living room. (No selling or gambling - not by phone or in person - NO PERSONAL CONTACT EVER!) The way I make money is somewhat unusual, but very clever. It's not magic, and it's not crazy gimmicks or tricks. It's just based on real life facts and success - not theory. It's a specific and definite money-making process that will work for you exactly as it's working for me and several others. I'm talking about real money you can buy things with the minute you receive it. In fact, this just might be the shortest legal way to make money that has ever been invented, and it's practically a sure - NOT A DANGEROUS GAMBLE. I'm also excited to say that it's 100% legal, honest, and ethical - 200% EASY.

THE AMAZING THING IS THE SPEED AT WHICH THIS SYSTEM WORKS!

And it only costs "pocket money" to test from your home or office. Make all your own hours . . . full time . . . part time, anytime! Don't worry, the money is always there and ready . . . enough to create a whole new lifestyle that lets you live and work as YOU please, anywhere YOU please!

BEST OF ALL, IT STARTS A LANDSLIDE OF MONEY COMING IN FOR AS LONG AS YOU NEED IT . . . DAY AFTER DAY . . . YEAR AFTER YEAR!

From personal experience I know that most money-making plans really don't work out in practice. It's a fact that there are very few ways for an average person, like myself, to easily make big money fast. For the past 10 years, I have spent in excess of $21,000 searching out and investigating dozens and dozens of money-making ideas. I've been determined to find the very best, honest methods of getting rich quick. Literally, I have bought and tried almost every money-making plan I could get my hands on. I've compared everything from import/export (World Trade) wholesaling, self-publishing, mail order catalogs, real estate and stock investments, thinly disguised pyramid schemes, chain letters, multi-level marketing junk, and dozens of different mail order methods with products that never sold. I've spent countless hours of "useless" energy trying to find the right one . . . a plan where the profits would be FAST and LARGE . . . a plan where there would be little work, little investment, and if possible . . . "no product." After all of that time and money wasted, I have discovered only one thing for sure - THEY ALL REQUIRED A LOT OF HARD WORK AND TIME . . . (usually 2-6 months to get started) . . . and money (usually $400 to several thousand dollars up front). And then, even after all of that, the profits . . . if any" . . . were usually very, very small. I've now come across something that has totally changed my way of thinking, my life, and my income for the better!

I honestly believe it to be the best system "OFFERED IN THE UNITED STATES TODAY."

HERE'S HOW IT WORKS:

It is a concept that is so SIMPLE and so fantastically INCREDIBLE that it would be hard to make a mistake, even if you tried. Perhaps the most important aspect of this method is it's overwhelming success rate. It's simple, effective, powerful and fun to do. It definitely eliminates all the hard work, time, and money which is usually required and does it in a way that is exciting, extremely profitable, and very fast! You will not only be amazed, you will be totally astounded. After spending 10 years and $21,000, I know for a fact that it is the absolute SHORTEST AND SAFEST way of making big money that I have ever investigated. And, this idea is repeatable OVER AND OVER AND OVER AGAIN. It will make an instant believer out of anyone who sees it for the first time - IT'S EASY AND IT PRODUCES MONEY-FAST!

If you can follow my simple instructions, page by page, you'll be in for an excellent surprise. This can be done at your own convenience while still keeping your regular job. You are free to choose the time YOU WANT TO WORK. You can operate my money making plan part-time, weekends only, or evenings if you like and still make a ton of money.

Forget about work and forget about risk . . . there is little of either involved. If you desire to earn money almost effortlessly, without scheming, selling, or borrowing-THIS IS IT! I'll show you exactly how to make this kind of money without giving up precious time with your family or putting a dent in your social life. The money will be yours, you can spend it on anything you like . . . exotic vacations, luxury cars, prime residential real estate, or anything . . . even starting your own company or business.

This technique is perfect for someone without a lot of money to invest because you can and should spend less than what amounts to $1.00 a day, annually, to test this proven concept. And there is so little risk involved I consider it almost insignificant.

Everything will be carefully disclosed to you in precise detailed steps, clearly, concisely, and in an easy-to understand manner. I'll send you the facts, actual working material, and instructions you need to make money at once. There is nothing magical about it. It's all "know how" and anyone, even a high school student, can learn to do this in approximately 30 minutes.

THAT'S IT - IT'S THAT EXPLOSIVE!

No more guesswork, no more hassles . . . nothing but straight, easy income. This has got to be the most valuable piece of inside information that money can buy - in my opinion, it's priceless! The money will start coming in directly to your home or office in only a matter of days. Every penny is yours to keep! It all comes in "cold cash," ready for you to spend right now. Spend only about twenty (20) minutes a day following up at home and do nothing else except watch the dollars keep coming in (instead of out) like magic. THINK ALL I DO! Anyone else receiving this money making plan can do it, too. IT'S SIMPLE AND VERY INNOVATIVE!

This technique can be used by anyone, anywhere, with a tiny bit of ambition. It's such an enjoyable way to make money, most people won't call it work-it's perfect for both men and women alike. Also, I don't care about your age, there is no physical labor involved-(you can be 18 or 80 years old). I don't care about where you live or what you do for a living or even if you are retired now. Your education level won't matter either-these things are totally unimportant. It's being done by people from all walks of life; plant workers, office people, shutins, grandmothers, farmers: plus doctors, accountants, salesmen, engineers, government officials, and lawyers. Who cares who you are or what you do? My program works for itself. It is respectable, exciting and extremely fun to do . . . nothing dirty or distasteful. You also won't have to write a book or spend a lot of time selling something (I call that work-this isn't)! All joking aside . . . if you spend more time on this, you are working too hard! I do this, if you can believe it, while watching the news programs on television at night.

ABSOLUTELY FOOLPROOF!

This plan will show you how to take in more money in a day than you now earn in a week . . . more money in a month than you now make per year, and more money in a year than anyone ever thought possible. Enjoy your life in a way that most people will only dream about. It would stagger one's imagination, while they are working 40 to 50 hours a week "earning a living," they are making only a fraction of what you will be making by WORKING ONLY PART-TIME, at home.

I apologize for having to charge $20 for my program, but the report and materials are not really expensive when compared to what you will definitely gain! It's my sincere desire to help you accumulate money for yourself by sharing my research. However . . . I cannot afford to lose money by making my work available to others. Please, don't tell me that just $20 will break you or that it's too much to spend on yourself, your quality of life, or your family. (Over a year's time, this works out to only 6e a day-that's less than a cup of coffee a week!) If you are having trouble affording that, then you need this information right now-AND FAST! You are going to COME ALIVE with excitement!

I can understand that the enclosed material sounds a bit far-fetched. Part of your skepticism probably comes from not knowing who you are dealing with. I am not a "wheeler-dealer," or a "high-roller," or a financial "wizard." I'm just an honest, hard-working businessman whose parents were simple and hard-working people as well. My father taught me to give an "honest day's work" for an "honest day's pay."

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As you can tell by now (to say the least), I have come across something pretty darn good. All in all, as I said at the start, I believe I've discovered about the "sweetest" money-making secret you could ever imagine. THIS SYSTEM IS SIMPLE . . . SIMPLE TO UNDERSTAND . . . AND SIMPLE TO USE. I've never been more certain of anything!

It's a wonderful feeling to build a goal based squarely on bringing hope and happiness to others. For the first time in my life I wake up happy every morning for a change. It is happening to others, why not you? To let this opportunity slip by you right now would be a definite shame. It you put this offer aside, without ordering right now, we both lose out. I'll miss a modest sale and the pleasure of giving you success; you, on the other hand, will likely throw awey the greatest chance you've seen to "finally make it." You may never know how GREAT IT FEELS to have $120,000 in the bank to spend any time you need it for emergencies. You may never know what it's like owning three luxury cars valued at $130,000. And, you may forever wonder what it's like to own a prestigious home worth over $360,000 in perhaps the best neighborhood in your state.

I know you are interested in a method ol obtaining "immediate extre income." SO, PLEASE, THIS TIME, ACT! IT'S WORTH SEEING!

ROCK-SOLID GUARANTEE

Put my money-making system into use. Be able to solve all your money troubles. And if for any reason you are not totally excited about the money thet flows in after using the secret for 30 days, you may return my material for a full refund of your money.

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As always, the future is yours. The decision that you make right now can determine how rosy, or how bleak that future will be. So please, make the wise decision and fill in the order form below, right now. You're going to be really glad you did.

Rush $20 to me and I'll ship this program to you immediately. (I'll pay all shipping, processing, and postage for you!)

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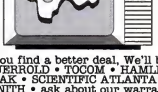

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Wilkinson 5 Pak + 2 Free razors	0.52 pk
Wilkinson 10 Pak + 4 free razors	0.92 pk
Gillette Gd News 2'e (1 2-2'e cct)	5.52 cd
Gillette Good News 12 in bag	2.76 bg
Gillette Atra II 5's	27.60 dz
Gillette Trac II 9's	41.40 dz
Gillette Atra 5's	27.60 dz
Gillette Atra 10's	41.40 dz
Wilkinson S.D.E. (3 dz/box)	5.52 dz
Bic Disposable 5 Pak (288-5's)	0.83 pk

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5" Black Unbreakable 1 gr	$4.14 gr
8 1/2" Black Afro Comb 3 gr	14.08 gr
6 1/2" Black Afro Pik 2 gr	14.08 gr
9" Ladies Asst Colors5 gr	18.22 gr
6" Afro 72 in Drum 6 drums	6.90 dz
10 Asst Cmbs in bag 144 bags	0.40 bg
20 Asst Cmbs in bag 72 bags	0.81 bg
Minimum Carton lots only	

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Mens Fold, Short Auto Ladies Easy Folding	5dz.	$21.28 dz
Auto PB Solid or Print	5 dz	21.28 dz
Mens Long Black PB	5 dz	37.38 dz
Mens Long Golf PB	5 dz	37.38 dz
Shoulder Strap	4 dz	37.38 dz
Mens long Doorman	2 dz	73.60 dz
Open cartons add $2.30 dozen		

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22189 Electric	12 Pcs	$3.44 ea
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15033 Keno Wind Up	24 Pcs	5.46 ea
15394 Bell Wind Up	6 Pcs	7.46 ea
44500 Travel Alarm	6 Pcs	5.06 ea
Open cartons add 29¢ each		

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Speed - 10,000 RPM, Orbital, Stroke - 3/16 Inch, Average. Air Consumption - 4 CFM. Recom. Air Pressure - 90 PSI.

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Orbital Sander

Speed - 8,000 RPM, Orbital Stroke - 3/16 Inch, Pad/Paper. Size - 3 2/3" x 9" Average. Air Consumption–6 CFM.

Sugg. Retail $39.95 — Single $24.75
#77-020 10/CS Ship. Wt. 4lbs. — 6 or more $21.85

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Set Consists of One Long Barrell Chrome finish Air Hammer, One Spring Retainer, One Fitting and Alt Purpose Chisele. Blows Per Minute - 3000 • Stroke–2 5/8" • Average Air Consumption–4 CFM • Recom. Air Pressure - 90 PSI. Sugg. Retail $29.95 — Single $10.95
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Mskng Tpe 3/4" x 60 yds	(4 dz)	7.46 dz
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Mens Stretch Dress Sox	(10 dz)	8.28 dz
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#71-080 40/CS Ship Wt. 1 lbs. 6 or more $2.90

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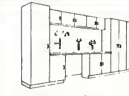

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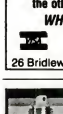

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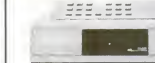

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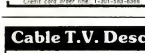

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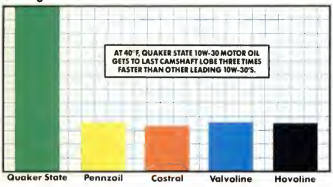

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